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Defining Business Benefits for Network Technology Lifecycle Management

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The target of the present thesis was to investigate the challenges related to life cycle management of network technology from a profitable business administration point of view. Another aspect was to find out if a more efficient process would be found to support the life cycle management of the network technology at the target organisation.

The theoretical framework of the thesis consisted of return of investment, process description and development and life cycle management of products and technology.

Action research was used in the thesis. The research started with a present situation analysis utilizing the existing internal material and having meetings together with the key experts. In order to gather all the facts about the network, a number of internal information technology systems as well as network management systems were used. A SWOT – analysis was created together with Finnish technology experts.

The present situation analysis revealed the risks clearly. The analysis also showed very clearly the consequences of postponing technology investments. Based on the analysis, a need for a more efficient and systematic process was discovered alongside with a need for calculating and verifying the economic grounds for renewing technology.

Three different geographical areas were used as examples. The areas were analysed by the network planners in order to have a holistic view about the present network and the required re-investments for replacing the old technology. The payback time for all three areas was less than five years. During the process it became evident that a new broader process has to be developed for supporting the network technology migration. The process was developed as a part of the research.

The outcome of the research was the business economic evidence for renewing technology. Another outcome was the new coherent and efficient technology migration process. The most remarkable change was that mobile network planning process and fixed network migration process have been merged.

Keywords	Technology migration, return on investment, life cycle management, project management, process development

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Tämän työn tarkoituksena oli tutkia verkkoteknologian elinkaarenhallintaan liittyviä haasteita esimerkiksi kannattavan liiketoiminnan näkökulmasta sekä voisiko tehokkaampi prosessi tukea verkkoteknologian elinkaarenhallintaa. Teoreettinen viitekehys koostui investoinnin takaisinmaksuajasta, prosessikuvauksesta ja -kehityksestä sekä tuote- ja teknologian elinkaaren hallinnasta.

Kehittämistehtävä toteutettiin toimintatutkimuksena, joka aloitettiin nykytila-analyysillä hyödyntäen olemassa olevaa materiaalia sekä kokoustamalla avainosaajien kanssa. Luotettavan tiedon saamiseksi hyödynsimme sisäisiä tietojärjestelmiä sekä verkonhallinnan työkaluja. SWOT – analyysi tehtiin yhdessä suomalaisten teknologia-asiantuntijoiden kanssa, jossa selvitettiin kyseessä olevan teknologian vahvuudet, heikkoudet sekä mahdollisuudet ja uhat tulevaisuudessa.

Nykytila-analyysi paljasti teknologian riskit hyvin selkeästi. Teknologiainvestointien lykkääminen vuosi vuodelta näkyy myös nykytila-analyysissä selkeästi. Tästä syntyi ajatus systemaattisemman prosessin kehittämisestä sekä laskea ja todentaa liiketaloudelliset perusteet teknologian uudistamiselle teknologian elinkaarenhallinnan ajamana.

Tuotantoverkosta otettiin tutkinnan alle kolme erityyppistä maantieteellistä aluetta, joista kaksi oli suuria alueita ja yksi pienempi alue. Alueet analysoitiin verkonsuunnittelijoiden toimesta kokonaisvaltaisen verkkoteknologiavaihdon näkökulmasta, jolloin selvisi kuinka paljon vanhaa teknologiaa alueella on ja kuinka paljon alueelle pitäisi investoida, jotta vanhasta verkkoteknologiasta pääsisimme eroon. Kaikkien kolmen alueen osalta investointien takaisinmaksuaika oli alle viisi vuotta. Työn aikana on tullut selväksi että kokonaisvaltaisen prosessin kehittäminen on välttämätöntä, joka myös luotiin tukemaan verkkoteknologia migraatiota.

Työn lopputuloksena saatiin liiketaloudelliset todisteet verkkoteknologian uudistamiselle ja sen tuomalle hyödylle yritykseen. Lisäksi kehitimme yhtenäisen verkkoteknologiaprosessin tukemaan tätä toimintaa. Merkittävimpänä muutoksena organisaatiossa tapahtui mobiiliverkon suunnittelun ottaminen mukaan tukemaan kiinteän verkon migraatiota.

Avainsanat	Teknologia migraatio, investoinnin takaisinmaksu, elinkaaren hallinta, projektin hallinta, prosessin kehitys

Contents

1 Introduction

Telecommunication business is currently having a big challenge in terms of profitability and revenue growth. This requires intelligent investment management and balance between capital expenditures (capex) and operational expenditures (opex). In the Thesis I will analyse whether transforming old technology to new technology return of investment is less than five years.

Another aspect is to study whether technology transformation, i.e. migration, will reduce complexity in the networks by reducing the number of network elements in production.

The third goal is to develop current migration processes to support coherent technology transformation (migration) covering both fixed and mobile network planning.

It is a fact that even from the technology point of view only, technology has to be renewed regularly because it has a certain limited life cycle in itself. This subject has been under discussion for years, but due to limitations in investment budget and savings targets, the needed renewal of technology has not happened. Therefore, I believe it is important to go through the current situation and calculate possible business benefits and return on investment to be presented for the TeliaSonera Technology Finland management. The focus for the Thesis is network technology. Product and customer migration, i.e. moving customers from existing old services to new services, is an important part in successful change processes as such, but I have left this out of the scope of this Thesis.

This Master's Thesis is going to focus on three main areas. Research questions will be based on these three main focus areas.

1 Create return on investment calculation for three different geographical areas in Finland.
2 Look into the processes and develop an improved new process for migration.
3 Look into life cycle management mainly focusing on network technology life cycle management, but also touch product life cycles.

This Thesis is an Action research. A lot of help and assistance will be needed from network technology specialists, network planners and business controllers. The aim is to have regular meetings together with key employees to be able to get the best and most reliable information about the production network.

The theoretical frame work is going to consist of technology related business economical literature, process development and life cycle management related literature. Based on literature and author´s own experience and master degree studies the target is to find answers to the above three focus area questions to support TeliaSonera Finland's business and strategic targets.

2 Company introduction

TeliaSonera is an international company with local sales, operations and brands. That's why it is important to understand both TeliaSonera level and TeliaSonera Finland level organisations and how global and local organisations are cooperating.

2.1 Introduction of TeliaSonera

This is a brief introduction of group level organisation. TeliaSonera provides network access and telecommunication services that help people and companies communicate in an easy, efficient and environmentally friendly way. (TeliaSonera Internet, 2014.)

International strength combined with local excellence is what makes TeliaSonera truly unique - and provides a world class customer experience, all the way from the Nordic countries to Nepal. This combination has brought ground breaking 4G, a world class fibre network, and introduced 3G at Mount Everest. (TeliaSonera Internet, 2014.)

TeliaSonera offer services in the Nordic and Baltic countries, the emerging markets of Eurasia, including Russia and Turkey, and in Spain. (TeliaSonera Internet, 2014.)

In May 2011 TeliaSonera was united under one common symbol and identity. When you see this symbol, you will know that you are not only dealing with a local telecom

operator - you are plugging into the world of TeliaSonera, a world filled with new and exciting possibilities. (TeliaSonera Internet, 2014.)

TeliaSonera founded in the 1850's and at that time they were pioneers of the telecom industry, one of the inventors of mobile communications and founders of GSM. They are committed to continue to drive the information society and to constantly take the customers one step further. TeliaSonera have evolved from local operators into Europe's fifth largest – in less than 20 years. (TeliaSonera Internet, 2014.)

True to TeliaSonera's heritage as telecommunication pioneers they continued to invest in high quality networks to meet the demand for bandwidth. Together with their partners and suppliers they will ensure that the customers have access to the best solutions available now and in the future. TeliaSonera will continue to focus relentlessly on ensuring a superior customer experience. (TeliaSonera Internet, 2014.)

This Master's thesis will focus on TeliaSonera Finland. That's why introduction of the target organization will be focusing on Finland.

2.2 Introduction of TeliaSonera Finland

This is a brief introduction of local company TeliaSonera Finland, which is known as Sonera in the Finnish markets and customers. The telecom industry is a very important part of the Finnish infrastructure. The most important telecom services have become a commodity comparable to electricity and water. Mobile communications usage is high in Finland. The mobile market is well developed with intense competition and a large number of suppliers. The market for fixed communications is heavily fragmented with a large number of local operators. (TeliaSonera Internet, 2014.)

The Finnish telecom industry is affected by a country with populous southern areas and sparsely inhabited Lapland. Sonera is the oldest serving operator in Finland and has the vastest coverage of both 3G and 4G in Finland. Sonera is also the first operator to open 4G in 2009 and to launch it to the public in 2010. In 2011, the introduction of new 4G devices enabled the breakthrough of commercial 4G in Finland. In 2013, Sonera has connected 40 percent of the population in 50 cities and locations to 4G operators. (TeliaSonera Internet, 2014.)

In 2012 Sonera launched ground-breaking selection of mobile subscriptions, "Sonera Exact" i.e. “Sonera Sopiva” in which voice, SMS and data within the Nordics and Baltics is included in the monthly fee. (TeliaSonera Internet, 2014.)

Within the fixed network, Sonera is the only nationwide operator with 500,000 customers. The ever increasing need for IP based entertainment in the market is evident - during the past two years the amount of Sonera’s TV customers has doubled to 403,000. The cornerstone for IP based TV solutions is ensuring that the increasing number of Finns has access to Sonera’s fast connections. In 2013, more than half a million consumers are able to benefit from Sonera’s 100 Mbit/s connection which is the fastest connection in large scale consumption. The pilot for 1 Gbit/s connection was started in 2010 and will soon be offered to new sites constructed from the outset with fiber operators. (TeliaSonera Internet, 2014.)

2.2.1 TeliaSonera Finland Organization

The organizational structure in Finland follows the same structure as in other geographical areas. High customer focus is illustrating also the organization due to clear segmentation by consumer-, enterprise- and operator customers.

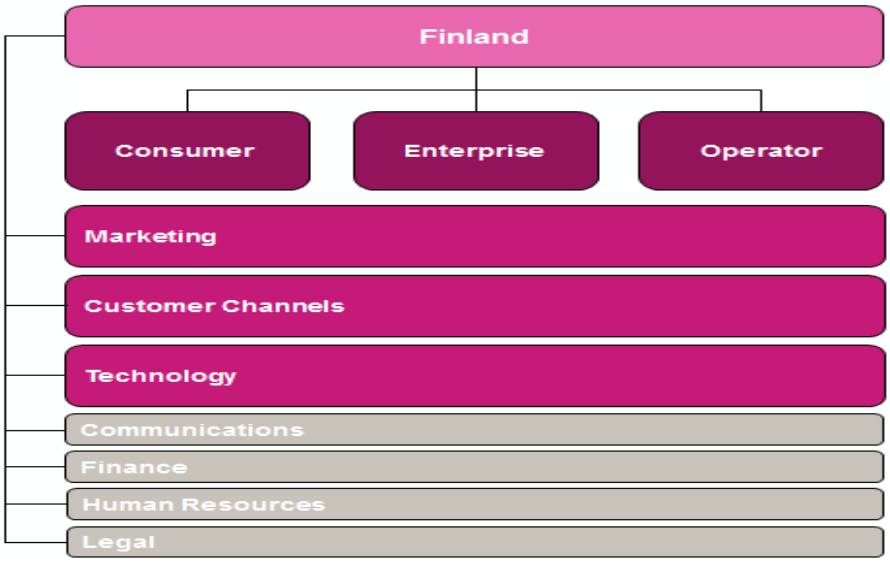


Figure 1. TeliaSonera Finland organization since 1st of April 2014. (Reference TeliaSonera Internet 2014.)

2.2.2 Country Technology organization

This Master's Thesis is done for TeliaSonera Finland's Technology unit. The unit is responsible of network planning and deployment in Finland and have capex and opex responsibility. The unit is also responsible of products and services life cycle management and local technical platforms life cycle management as well as service assurance and operations. Local IT support systems are also an important part of the technology unit.

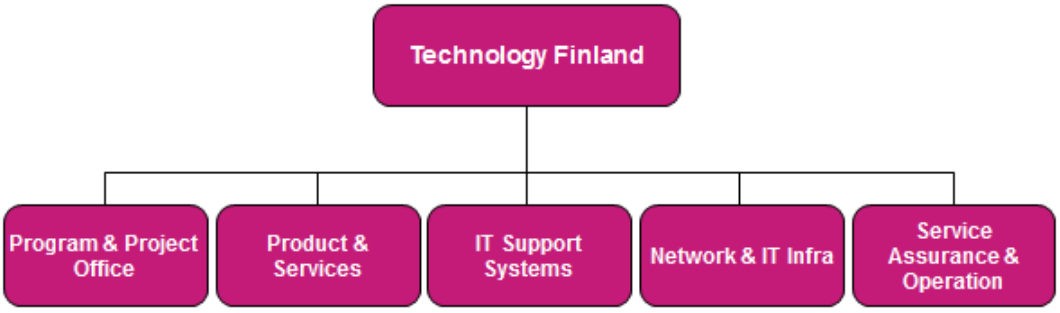


Figure 2. TeliaSonera Finland, Technology organization since 1st of April 2014 (Reference TeliaSonera Internet 2014.)

2.2.3 Brands

Sonera has a complete range of mobile services and is one of the leading mobile operators in Finland. Sonera is also a large provider of fixed communications and TV. The operator offers communication services and broadband access to businesses and consumers across the country and has a strong presence with a complete selection of fixed services in the northern, eastern and south western areas of Finland. The company provides wholesale services in both mobile and fixed communications. Sonera has its own sales channels as well as a far-reaching network of external dealers. (TeliaSonera Internet, 2014.)

TeleFinland is a low-cost and easy to use mobile operator targeting all customers in the consumer market who value basic services and low prices. Current ownership is 100.0%. (TeliaSonera Internet, 2014.) It is important to realize that TeleFinland is using the same underlying network as Sonera.

Cygate is a leading supplier of secure and managed IP-network solutions and system integration in the Nordic region. Cygate customs and tailors platforms that enable companies to handle all their communications in one and the same solution. Cygate offers a total undertaking or a free choice of services, products and solutions for IT infrastructure with the highest possible availability and security. Crescom, a data center service provider and Cygate merged on January 1, 2012 and operates under the brand Cygate. Current ownership is 100.0%. (TeliaSonera Internet, 2014.)

2.2.4 Penetration

Mobile penetration in Finland is 180%. The high percentage reflects the fact that many customers have several mobile subscriptions (sim cards) in use. Fixed telephony has a 21% penetration and Broadband services a 29% penetration in the Finnish market. Here Sonera has a market share of 31%. Penetration data 2011 and Q1 2014 peers final report. Sources: Statistics Finland, IHS Global Insight

Mobile communications usage is high in Finland. Around 80 percent of all voice minutes are mobile. The mobile market is well developed with intense competition and a large number of operators. (TeliaSonera Internet, 2014.) Mobile network is still one of the main users in Sonera’s old legacy network called synchronous digital hierarchy (SDH).

The market for fixed communications is heavily fragmented with a large number of local operators. Like in TeliaSonera's other home markets, usage of fixed voice is decreasing while demand for broadband solutions and TV is increasing. (TeliaSonera Internet, 2014.) Fixed communication network is another of the main users in Sonera’s old legacy network called synchronous digital hierarchy (SDH). Due to the fact of decreasing business of fixed communications, transforming old legacy network technology to new future proof technology is even more important.

2.2.5 The vision of TeliaSonera

TeliaSonera is a world-class service company, recognised as an industry leader. They are proud pioneers of the telecom industry, a position they have gained by being innovative, reliable and customer friendly. Wherever they operate, they act in a responsible

way, based on a firm set of values and business principles. TeliaSonera's services form a major part of people's daily lives – for business, education and pleasure. TeliaSonera acts in a responsible way, basing our activities on a firm set of values and business principles. (TeliaSonera Internet, 2014.)

2.2.6 The mission of TeliaSonera

TeliaSonera's mission is to help people and companies communicate in an easy, efficient and environmentally friendly way, by providing network access and telecommunication services. (TeliaSonera Internet, 2014.)

The focus is to deliver a world-class customer experience, while ensuring the quality of the networks and maintaining a cost efficient structure. TeliaSonera is an international group with a global strategy, but wherever TeliaSonera operate, they act as a local company. (TeliaSonera Internet, 2014.) You may assume that renewing technology will improve customer experience and quality in the networks. The thesis will support TeliaSonera's vision and mission.

2.2.7 The strategy of TeliaSonera

TeliaSonera is an international company with a global strategy, but wherever we operate, we act as a local company. TeliaSonera provide network access and telecommunication services that help people and companies communicate in an easy, efficient and environmentally friendly way. (TeliaSonera Internet, 2014.)

TeliaSonera's strategy is to deliver products and services that are tailored to our various customer segments and based on a deep understanding of their present and future needs. We create shareholder value by delivering our services in a cost effective and -sustainable manner, which leads to sustainable improved profitability and strong cash flow. (TeliaSonera Internet, 2014.)

Three major challenges described in the Internet are that TeliaSonera's customers' behaviour has been affected by the rapid digitalization of data within our society. Usage has become more dynamic and enhanced by videos, moving images, interactive enter-

tainment and social networks. With consideration to this development, we believe our industry faces three main, imminent challenges:

1) Continued rebalancing of data pricing to follow current business models.

2) Fixed-mobile convergence and bundling of services. (i.e. possibility to access the services using whichever terminal, mobile phone or PC or tablet from location independently.)

3) Development of value-added services linked to our core business, e.g. cloud storage and virtual meetings. (TeliaSonera Internet, 2014.)

As an industry leader TeliaSonera is bringing for corporations and customers value quality, flexible product portfolios for corporate customers, outstanding customer care and early implementation. Mobile internet has revolutionized the business landscape. TeliaSonera understand the customers' needs, which includes High-quality networks, meaning that the services are reliable in terms of coverage, speed and up-time. World-class customer experience striving to provide easy-to-use services with a "touch and feel" experience is the target picture. Business-to-business (B2B) product portfolios for assuring that the customer needs are met with integrated business solutions. Early implementation with the aim to get new technology and services to customers faster is a target, as well as Competitive pricing to exploit the potential of economies of scale. Sonera's unified brand. The customers trust a brand they know. The unified brand further strengthens TeliaSonera's position on the international scene by manifesting TeliaSonera's unique combination of international reach and local connection. (TeliaSonera Internet, 2014.)

Sonera's aim is to be seen as the most attractive brand in the telecommunication industry in each market, providing the best customer experience. Sonera also aim to be viewed as smart, innovative and local, wherever it operates. (TeliaSonera Internet, 2014.)

3 Research scope and limitations

In this chapter the scope of the research has been described as well as the main measurements of the research result. The chapter includes the limitations of the research and research questions. I will also elaborate on the definition of the technology migration.

3.1 Research scope

The research scope is on networks which were built in the time period of 1970 until early this century. These are technologies that are not developed any further but are mostly in the end of the lifecycles. The technologies have been used in telecommunications networks to transport large quantities of data over digital transport equipment such as fibre optic and micro-wave radio systems.

The technologies are using standardized protocols, which transfer multiple digital bit streams synchronously over optical fiber using lasers or highly coherent light from light-emitting diodes (LEDs). At low transmission rates data can also be transferred via an electrical interface. (Wikipedia, 2015).

The fixed network in this Thesis is the network consisting of two different kinds of technologies which are mostly end of lifecycle, which means that there is no support available from the vendors and there are no new spare parts available. Business case calculations will be made for two chosen major geographical areas and one smaller area in Finland.

One of the targets is to clarify whether replacing old technology with new will give business benefits for TeliaSonera and return on investments is less than five years. Another scope is to understand the present situation and look into the network life cycle management. Further scope is to evaluate current processes and based on the information, to develop a new common migration process from a holistic point of view. If possible the process will be tested in one of the geographical areas where the target is to dismantle the area from the old technology.

3.2 Definition of migration

In this context migration means that something old will be replaced by something new. This applies both for the products and services customers are using as well as the technology used in the production network. The fixed network technologies are used in the existing production network, but have reached end of life phase. In this context end of life means that the network operator cannot get any support or any spare parts from the suppliers. The consequence of this is that operators have to handle everything by themselves. This increases the risk of having major incidents in the network and delays in the fixing of the incidents. Therefore management of technology lifecycle and replacing old technology with new is mandatory. However, this has been a challenge in TeliaSonera Finland due to capital expenditure (capex) limitations. Therefore it is extremely important to have a positive business case by having return on investment (ROI) less than five years. In other words, technology migration has to give business benefits for TeliaSonera Finland.

3.3 Research target measurements

One of the measurements is to produce a business case calculation by calculating needed investments and how much savings can be achieved by renewing technology. One critical component in the calculation will be energy consumption. Also the number of fault cases has to be taken into account. The second target measure is to reduce complexity in the network by reducing the number of network elements on the specific site. This can be proven by simple calculation of the network elements in the specific sites. The third target measure will be the process definition and implementation of the process during the pilot project.

However, the importance of maintaining current revenue streams and customer relationships cannot be ignored when calculating the total cost of ownership and the cost benefits. The main reason for this is that by renewing the technology you will be able to extend customer and product life cycle and secure existing revenues.

3.4 Research limitations

Product life cycle and product changes are out of the execution scope, as otherwise the work would become too complex. However, when developing a process description, a product migration has to be included into the thesis work. “Product” in this context means a product/service that the end customers are using. Examples of a product: A Voice product for a consumer customer, where the customer has a telephone at home, or a telephone system product/service for a business customer. The importance of product migration should not be underestimated as it is a vital part of the migration work to make it successful. Customer revenue will not be part of this research as it will be impossible to have reliable, geographical area based revenue information.

3.5 Research questions

In the study I will investigate whether technology migration, i.e. replacing the old technology with a new future proof technology, enables return of investment less than five years.

I would like to find an answer to the following questions:

- Main research question:
  - Does technology migration enable business benefits for TeliaSonera Finland?

- Other research objectives:
  - How to find the optimal time for migration?
  - How does return on investment look like in those selected geographical areas
  - How to develop profitable network technology life cycle management?

I will look into this by having meetings together with business controllers and engineers within Sonera. Based on the regular meetings and discussions I can evaluate the current situation. By understanding the theories in return on investment and process development, I will suggest improvement areas in the organization I work for and hand it over to implementation.

4 Present situation analysis

This is the analysis of the present situation of the old legacy part of the production network and how life cycle management has been handled currently in TeliaSonera Finland. The last chapter is describing the present situation of the processes.

4.1 Analysis of the network

The old fixed network is providing transmission capacity to both internal and external customers. It is an important part of the core and aggregation network assuring customer quality demands.

- Most of the capacity (90%) is for internal customers.
    - The biggest capacity user is Mobile Services. Nowadays all 3G base stations are based on future proof technologies. Mobile Services have a detailed plan to move all services on top of future proof fixed network technology within four years if budgets will allow.
    - The second biggest user is Fixed Voice which has no equivalent plan for migration yet.

Sonera's transfer capacity which is based on the old network technology is still required by other telecom operators, broadcasters, large corporations as well as government organizations. This is because the old technology offers secure, reliable dedicated networks with guaranteed capacity and service quality for all kinds of communications. Customers are using for example for voice communication, video communication and data transfer between offices. Service quality is based on efficient protection methods. Efficient protection to ensure security is one of the main benefits of the old technology and one of the reasons it still is in production.

2Mbit/s capacity which is based on old technology is regulated and the regulation is controlled by Finnish communications regulatory authority (Ficora). The prices of regulated products must be public and those are illustrated in the picture below.

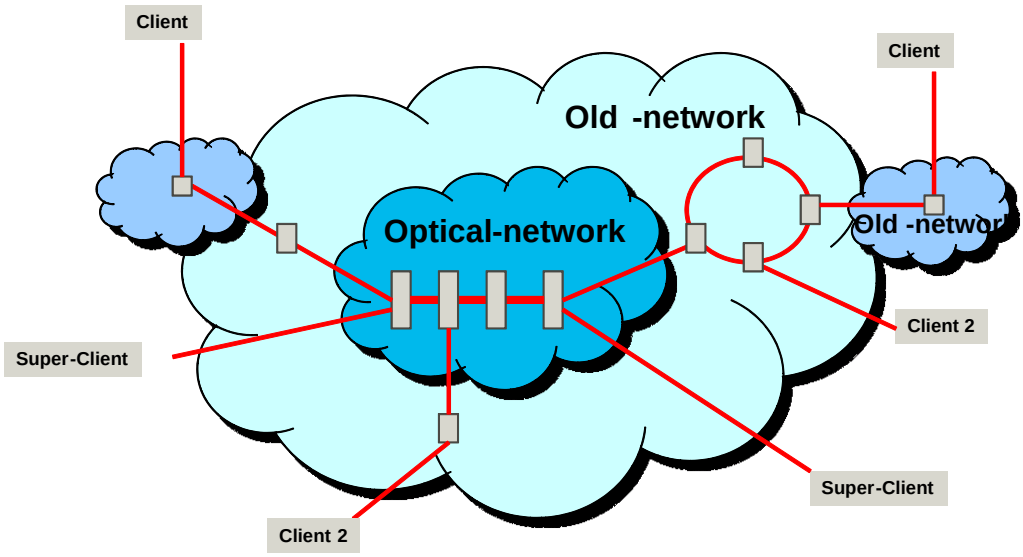


Figure 3. High level description of old fixed network (Eskel et al. SDH Strategy, 2010).

Year after year more end of life network elements will be in the production network. The most critical situation will happen after 2016 when most of the old fixed network elements will be end of repair. This means that TeliaSonera Finland will not receive any support or new spare parts from the vendor. This means that TeliaSonera Finland have to establish their own spare part management process and secure availability of the spares internally. Handling an increasing number of spare parts will increase operative costs.

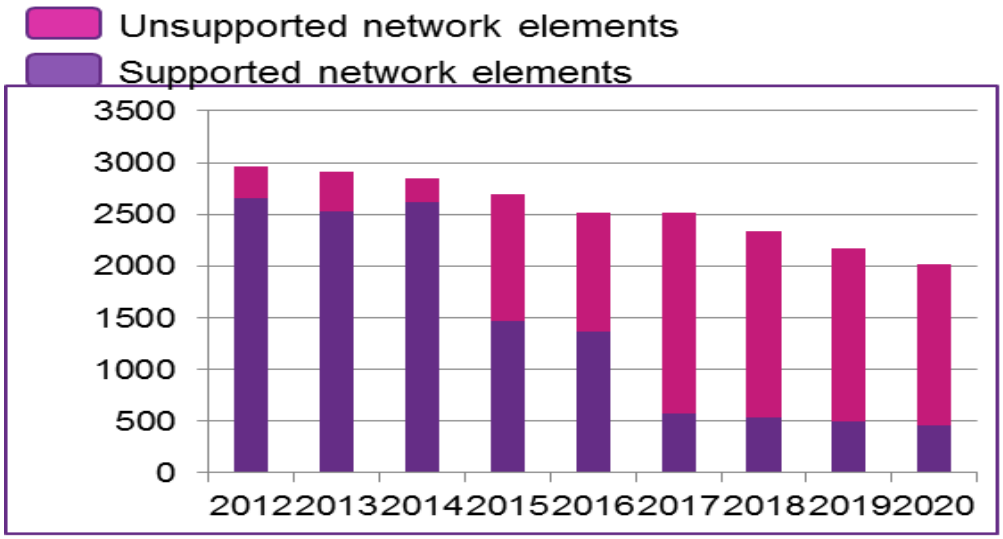


Figure 4. Life cycle of old fixed network elements in Finland (Eskel et al. SDH strategy, 2010).

The figure above describes the situation in the old fixed production network in the case that TeliaSonera will not start active technology migration. The situation will get worse during 2015 when approximately 50 percent of the fixed network elements will reach end of support status. The situation has developed over the years mainly because of limitations in investment money and there has also been a general assumption that the fixed network is profitable. The fact is that during 2017 the situation will reach a critical point, as more than 80 percent of the fixed network elements are at end of life. The situation will be critical because of increasing volume of spare part handling and increasing risk of having major network incidents.

4.1.1 Products in use

The Sonera Network Capacity Product is a service solution for full circuit capacity between two specified demarcation points and specified connection interfaces. Transmission rates used in production varies between 2Mbit/s and 155Mbit/s. In the core of the fixed network there are also capacities in use like 4*155Mbit/s and 622Mbit/s. This shows that the old fixed network is still a fundamental part of the network and also an important product element mainly for other operator customers who are using TeliaSonera Finland's operator services. The services customers are using are mainly connections in between two or several points of presence (POP's).

4.1.2 Old fixed network traffic volume development

Due to complexity in the old fixed networks and due to all variations in different capacities used in the production, all capacities have been calculated to 2Mbit/s connections. These can be considered as 2Mbit/s equivalents. Figure five illustrates how the number of 2M equivalents has decreased from 110000 to 45000 in Finland during the last five years. One reason is that one of the old technologies in the production network has already been dismantled. Another conclusion based on volume development is that the old fixed network migration has started to move mobile business services to the future proof technologies and protocols.

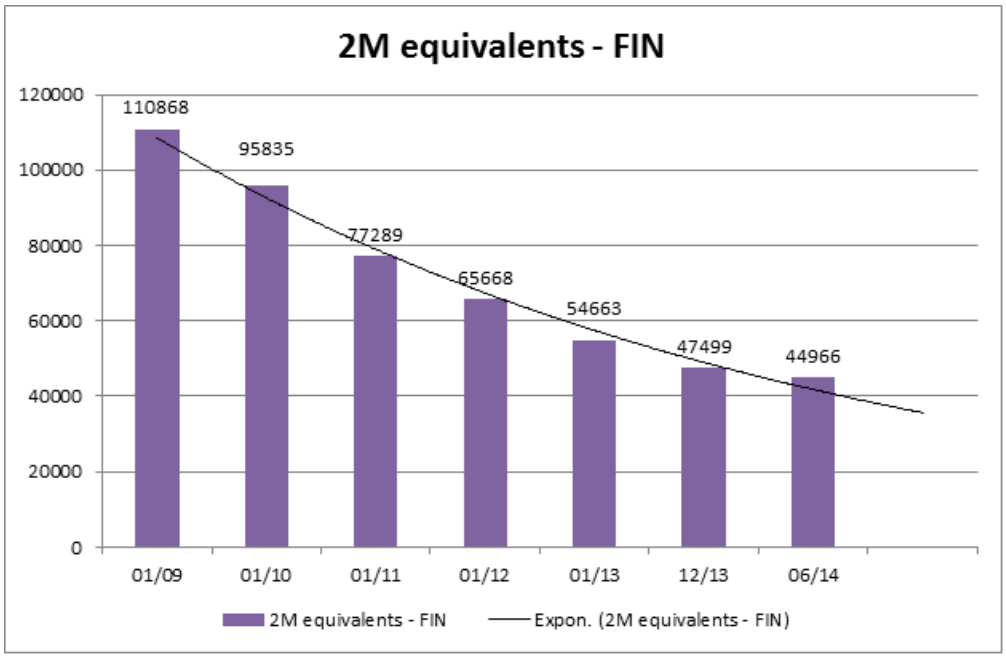


Figure 5. Capacity development of 2M equivalents by the end of June 2014.

The figure below illustrates the number of network elements in production in TeliaSonera Finland's network. The fixed production network in Finland has been constructed using a number of different equipment vendors over the years. Main equipment vendors have been Lucent, Synfonet and Ericsson. Lucent and Synfonet as a technologies are already end of life technologies. Lucent technology has already been dismantled in the network and Synfonet is under migration and phase out project. Ericsson's OMS is a more future proof technology. However it is crucial that the investments in old technology will be made only on mandatory basis. Ericsson's MSH is representing the greatest value in the network and will be end of life within a couple of years. It is evident that the capacity in use in the old fixed production network has declined by more than 60 percent, but the number of network elements has not declined as dramatically as illustrated in Figure 6.

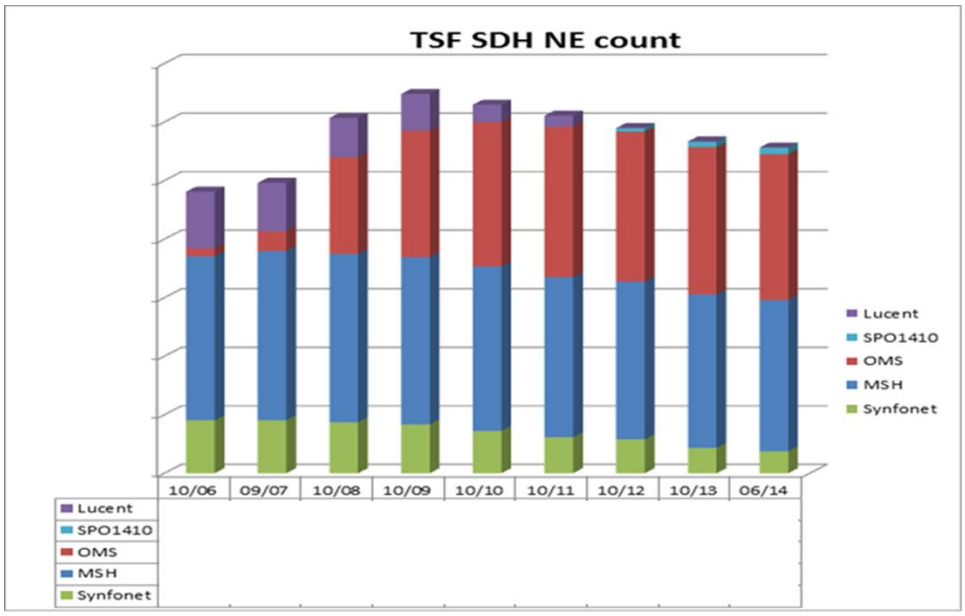


Figure 6. Volume development of old fixed network elements in TSF (Kumpula, 2015).

The figure clearly illustrates that more future proof platforms, such as Ericsson's OMS and MSH are still holding a good and solid position in the production network. Ericsson's SPO1410 has been used for replacing Synfonet in the network. This means that some investment has been made in old technology. The total number of network elements has declined approximately by 10 percent. When comparing the declining number of 2Mbit/s equivalents, the main conclusion about this is, that it is not possible to dismantle one single network element until all related circuits in the network have been removed. The decline in old fixed network elements started late 2009 when mobile back hauling connections were built mainly with more future proof technology in order to avoid investments in the old technology. This can be seen in the Figure 7.

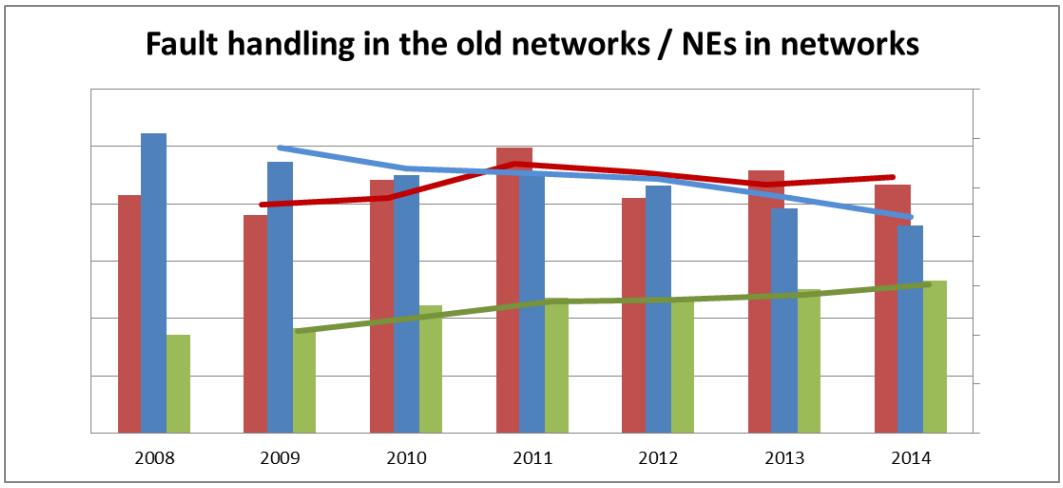


Figure 7. Development of fault cases sent to field versus number of NE's (Kumpula, 2015).

The figure gives evidence about competence disappearing both from the company but also from sub-contractors. The red line is showing the number of network equipment fault development between the years 2008 to 2014. In general the number of faults has been quite stable. The number of network elements, the blue line, has declined each year. The most interesting thing is that the number of fault cases sent out to the field operations has been growing year after year. It is quite evident that TeliaSonera Finland has lost competence and knowledge about old technologies and more fault cases are handed over to the sub-contractors because there is no knowledge in-house how to limit and analyse the fault by utilizing the network management systems.

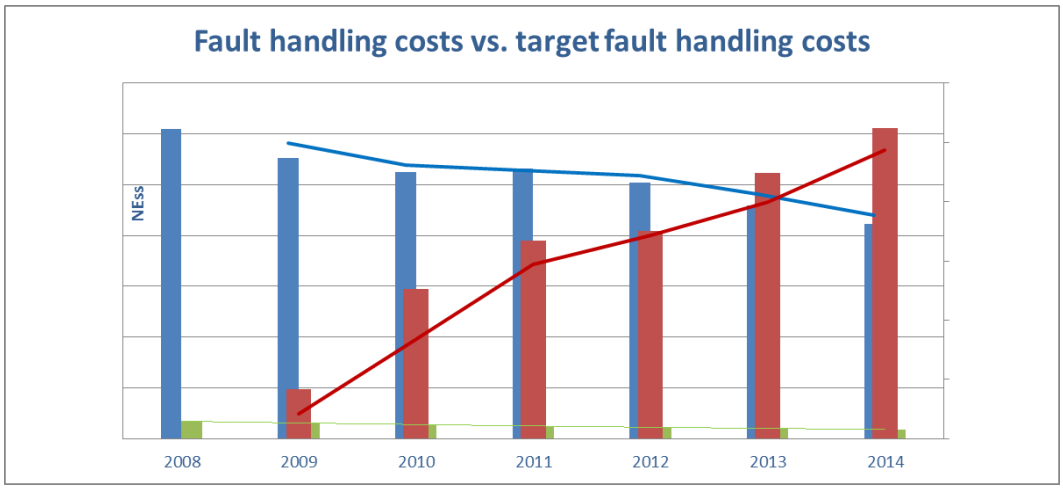


Figure 8. Development of the costs on fault cases (Kumpula, 2015).

Due to the fact that competence and knowledge about old technologies is disappearing, more expenses are accrued for TeliaSonera Finland. Figure 8 demonstrates this well. As stated in the previous chapter, the number of network elements is declining on a yearly basis (the blue line). The green line is theoretical, if TeliaSonera Finland would had sent the same amount fault cases to the field as in the early years, the cost would have remained quite low. As a reference, year 2009 is used in this case. The real outcome is shown in the red line. The cost has increased significantly over the years. The main reasons for this are the competence issue and spare parts handling, both internal and external. The cost figures have been hidden in the Figure due to confidentiality.

4.2 Analysis of the processes

The processes have been described on TeliaSonera level. The TeliaSonera Process Framework implements strategic decisions about how work is performed and describes TeliaSonera's shared decisions about the way of working. TeliaSonera process architecture describes process maps and gives a picture of how the processes should be built top-down for the most effective deployment. Process architecture is an agreed level of detail in describing work:

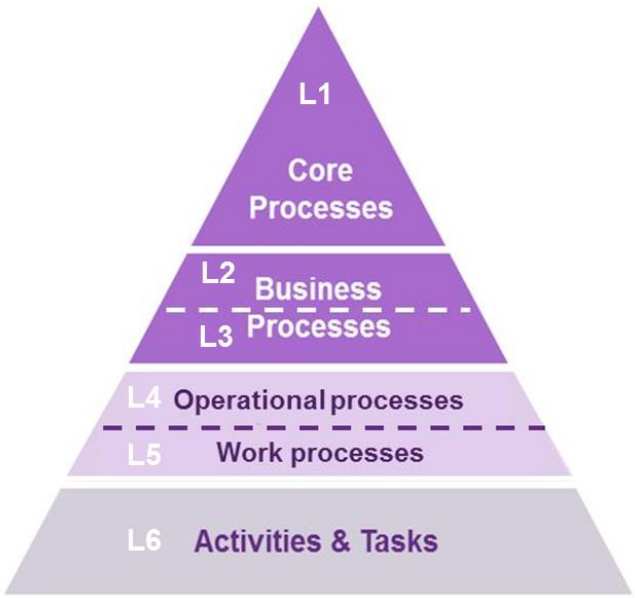


Figure 9. TeliaSonera process architecture (TeliaSonera intranet, 2015.)

The architecture has been divided in six different levels. Level 1 describes the core processes. The process domain creates value to external customers. The processes

should be simple, intuitive and communicative. Levels 2 and 3 describes business processes. The chain of key processes is to deliver value to customers. Both on the main as well as the sub level. Level 4 describes Operational Processes which should ensure a standardized approach to all work processes performed. Level 5 describes work processes, which have a relationship of activity flows that describe what is done in which sequence. Level 6 describes Activities and Tasks. An activity is a set of tasks required to produce a particular result. It identifies the value of work produced in processes (linked with performance measures). (TeliaSonera process description, 2014). When new network technology migration processes are being developed, this framework and architecture has to be taken into account. The retirement process is one part of a higher level life cycle management process description. Migration work should be part of this process but the description is on a too high level. The process flow describes that different alternatives should be specified. The process flow describes that different alternatives should be specified. After that the method should be specified and as a consequence of this the maintenance should be closed down. As part of the close down, customers should be migrated and network resources in question, should be removed from the production network. To be able to work according to the process description mentioned above, it will have to include more details on level six where activities and tasks should be elaborated, also including a workflow description.

The process used in TeliaSonera Finland for migration activities has been fragmented across the organisation. However the project manager for the Next Generation Networks (NGN) project has defined a process for migration as described in the figure 10. The current process is mainly reactive. This means that network elements in the old fixed network will be dismantled from the production network whenever they are emptied about of traffic. The traffic is disappearing due to a number of small activities and assignments run through TeliaSonera Finland’s organization. This is a very inefficient way of working which will not ease up the situation in old networks (Kuitunen, TDM Migraatio, 2). The Figure below describes current process for old fixed network migration.

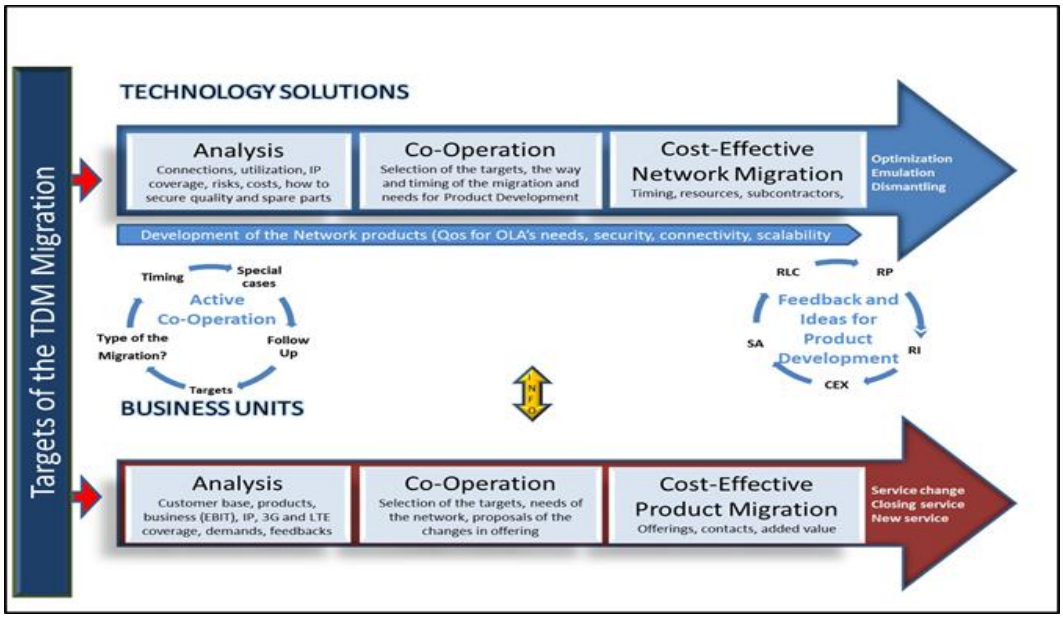


Figure 10. Main factors and Processes for successful migration (Kuitunen, 2014)

When looking into the mobile network part of the processes, the focus is mainly on radio access network (RAN) planning and optimization process. It is evident that fixed network requirements and especially the fixed network migration part are totally ignored. In the process definition it has been defined that the process has several starting points. The input to start the mobile network optimization may come from predefined areas and are periodically analysed by using an optimisation tool, and this tool detects issues and give suggestions for optimization work. Thus, reports generated by the radio access network optimization tool will start optimizing work. Automatic Cell Planning for the mobile network in TeliaSonera will be one form of input, meaning proactive optimization, but this only from a mobile radio access network point of view (Tuominen 2013, 3).

4.3 Analysis of life cycle management

There is a clear process and way of working defined within TeliaSonera how life cycle management should be handled. However investment limitations have had an impact on the production network as well as on customer products. Life cycle management currently consists of four main areas: Strategy and planning, development, maintenance and retirement. Strategy and Planning investigates and concludes issues as regards how the strategies, architecture and IT and network roadmaps should look like for the production. Development develops new or enhances existing products and IT

systems and services based on product and/or efficiency requirements. This covers the investigation, to the design and the hand-over to the executing organisation.

Maintenance is to manage existing IT and product/network resources, i.e. to support, uphold, adjust/enhance and to make resources available. Retirement provides Resource Implementation with all necessary pre-requisites, such as methods and tools to do the actual close down. It also makes sure that support systems are closed down. Closing down the systems has been one of the key challenges during the past years.

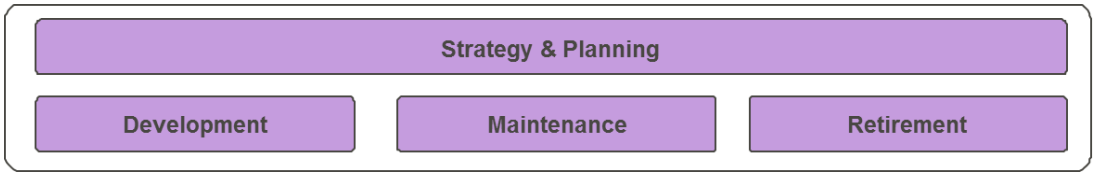


Figure 11. Main streams of life cycle management

5 Action research

Jeff McNiff has defined action research as a practical form of research methods which can be utilized when improving professional practicalities in different work places (McNiff Jean 1996, 7). This is exactly the target of this Master's Thesis. The primary target is to improve the current way of investment management and increase the knowledge of technology life cycle, which requires regular investments to maintain a certain level of quality.

The process of action research consists of two phases that differ analytically from each other. The target of the first phase is to clarify the original research question. However, the second phase, and the primary target, is to initiate a process of change and to maintain the process. There is also evidence that the description of the problem is never final (Greenwood Davydd J 1999, 33). That might be the case also in TeliaSonera Finland when implementing a new process. There will be change resistance, which is normal during the change. The new process will force some network planners out of their comfort zone, because they have to learn new ways of working and need to adopt new areas of technology.

In action research it is crucial to verify the arguments correctly. In this Master's Thesis the arguments will be verified critically against the proofs and include the informants to make their own conclusions (Somekh, Bridget 2005, 24). In this Master's Thesis the target is to establish a group of informants consisting of different competence areas, such as business controllers, network planners and technical specialists. The research questions have been evaluated together with them and will be evaluated critically together with the informants. This has become evident during this research by having a number of meetings together. The scope and target has been clarified during this thesis process.

Aaltola writes in his book that action research can be a dual research. According to the author of the book an action research is a way of working where the goal is to make changes in social functions but at the same time investigate the changes. An alternative as an action research target can be to help out people to investigate the reality in order to change the reality. (Aaltola et al. 2010, 214.) The target of this Master's thesis is to change the current way of working within migration projects by combining the projects and to create one process to support cost efficiency and efficient ways of working.

One starting point for an action research is a reflective way of thinking. This way of thinking it should enable a new way of understanding the function and by that a way to improve it. As an example of an action research, settled practicalities in a school environment could be taken under conscious evaluation, and then think of what kind of targets they are serving. (Aaltola ym. 2010, 219-221.)

From the researcher's point of view it will be interesting to notice that in a traditional way of researching the primary target has been to reach an objective level of information where the researcher is interpreting the target from a distance. In an action research this will be the other way around. In an action research the researcher will not aim to investigate the function as is without being present. However, the goal is that the researcher is making initiatives and has an influence on the target audience. (Aaltola et al. 2010, 223.) The researcher thinks that making his or her own initiatives is very important when executing the research in the target organization. The new ideas will be discussed and the ideas will be implemented and compared to the information gathered earlier. In addition some individuals can share their experiences and information related to that also outside of the community. Then one can conclude that he or she is making an action research. (Aaltola et al. 2010, 227.) This has been exactly the case in

this research. The researcher has been part of the process renewal and part of the team by thinking about how migration work and processes could be developed.

5.1 Interviews

Performing interviews is the most used method for qualitative researches. There are different forms of interviews. The most common one is theme interviews. Theme interview means a dialogue between two individuals discussing one subject at the time. The researcher has defined the subjects and the themes in advance, and they will be discussed together with an informant or with several informants. Deep interview is more relaxed compared with theme interview. Deep interview is known also as open interview. (Kananen, 70). In this Master's thesis interviews have been made by having a number of meetings.

Interviews together with observations are the most common ways of gathering material and information. This requires however, that a researcher and an informant have a common language of communication. An interview is suitable for certain situations and it produces typical information for the method. (Kananen, 71). This has been very important when discussing about migration together with informants. From the researcher´s point of view there has been a common language between the informants and the researcher, as well as common understanding about the importance of technology migration.

With theme interview a researcher is trying to understand and get knowledge about the phenomena of the research object, and there is always a person involved and his or her way of acting that a researcher is trying to open up with the help of themes. Questions and answers about the themes usually produce one small piece of understanding which may generate additional questions. An interview can be considered as a puzzle where the answers are part of the entity. By this way a researcher creates a holistic view and an understanding about the target of the research. (Kananen, 72).

In this research theme interviews will be used as a method for gathering detailed information about technology migration, used processes and how business case calculations are used to secure needed funding for executing migrations. Interviews will be executed during August – December 2014 by having recurrent bi weekly meetings together with the informants. A number of meetings have already been held about the

pilot area and gathering required detailed information about the production situation has been gathered, as well as and what new investments are needed to make things happen.

The core of the questions will be open questions with following additional questions. This is due to the fact that open questions will produce more and broad information and understanding compared to closed questions. (Kananen, 79.) Quite often new things will arise from the answers, when a researcher usually then raises additional questions. Following additional questions will produce arguments and viewpoints for the original question. (Kananen, 79.)

5.2 SWOT analysis

SWOT –analysis is a method to recognize your own Strengths and Weaknesses and as well as Opportunities and Threats. The analysis can be considered to be as risk management and every person involved in the project should participate the analysis and also give an opportunity to express him- or herself and share the his or her opinions. (Murch 2002, 191).

SWOT –analysis approaches the problem by four different questions.

1. Strenghts
    a. What are our strengths?
    b. Where are we good?

The questions should be evaluated from your own points of view and from those persons´ points of view whom are involved in the analysis.

2. Weaknesses
    a. Where can we improve?
    b. What are we not doing in a good way?
    c. What should we avoid?

These questions should be thought from your own points of view as well. Can other persons see weaknesses that you cannot see? Are competitors doing something better than we?

3. Opportunities
    a. Where can we find new and good ways of working?
    b. What are the trends we are interested in?

For example the following phenomena can enable useful opportunities.

- Small and big changes in the industry
- Changes in regulatory behaviour
- Changes in models, and profiles in population and changes in way of life and
- Events locally, nationally and internationally

4. Threats
    a. What kind of obstacles can be seen in front of us?
    b. What are the competitors doing?
    c. Are the requirements for work, products and services changing?
    d. Is the change in technology threatening our position?
    e. Do we have the management support?
    f. Do we have enough resources?
    g. Is the scope of the product under control?
    h. Do we use correct tools, programs and platforms?

According to Murch, project team and project managers should execute SWOT – analysis from time to time. The results are often clarifying the situation because they usually point out what kind of actions are needed and setting the problems in a right perspective (Murch 2002, 191–193).

In this research the present situation is analysed by using SWOT to evaluate the strengths and weaknesses, opportunities and threats. By using the questions listed above, it clarified the SDH technology production network strengths and weaknesses. The results are presented in chapter 7.1.

6 Theoretical frame work

6.1 Business case evaluation

Calculating the return of investment (ROI) has become one of the most challenging and intriguing issues facing the information technology (IT) sector (Roulstone & Phillips 2008, 1). Almost all IT professionals share the concern that they must eventually show a return on their IT investments (Roulstone & Phillips 2008, 2). This applies also to Networks unit in TeliaSonera, where the return on investment is calculated on a regular basis.

TS PROMO Business Case is an obligatory document included in TS PROMO to support both the project financial pre-study and the monitoring and control of the projects. The financial study and calculation help to determine and forecast what business benefits the project would yield to TeliaSonera. The business case is used for justifying the launch and continuation of the project, and so it also supports the financial benefit and expense forecasts. (Kainulainen 2012, 30.)

6.1.1 Preliminary study of the business case

The preliminary business case calculation will take into account energy consumption of old fixed network technologies. As a reference power consumption of one larger (SDH) network elements is four times bigger than of one smaller (PDH) network elements. The table below describes power consumption of certain old fixed network elements. The electricity price level has been assumed to be 10 cent/kwh.

Table 1. Power consumption per network elements. (Kuitunen, 2014.)

Network element	Energy kW	Cost/Month 0,1
PSTN Switch	7,5	540,00 €
Concentrator	0,2	14,40 €
DXX	0,2	14,40 €
PDH	0,1	7,20 €
SDH	0,4	28,20 €
Radio link	0,15	10,80 €

In the preliminary business case it can be used as an assumption that next generation IP based network elements will consume less power. This will be used as a project benefit. However one assumption is that achieved savings will not create a positive business case i.e. return on investment will more than five years.

In order to count all costs related to old fixed technology, one has to take into account vendor related support costs, repairing costs and subcontractor related fault fixing costs. In average the cost structure is the following:

- Vendor support costs are 50 000 euros per year
- Repairing costs are 115 000 euros per year
- Fault fixing costs are 750 000 euros per year

Based on a network statistics there are 2781 network elements in the production. This gives as an average cost figure per network element of 329 euro per year. This will be used as add on power consumption cost. These figures will be used as a base line for the business case calculations.

Current revenue streams running on top of old technologies can be shown only for the total network in Finland. Therefore revenue used in the business case will be indicative only and based on assumptions. However it will give some directional view about the benefits of expanding customer lifecycle.

6.1.2 Target setting for the business case

The target for the business case is to make an objective cost and benefit analysis with mobile and fixed services in the selected geographical area. The business case will contain needed capex for renewing the technology by using latest fixed and mobile technologies. The theory will be based on the book named “ROI for Technology Projects” written by Brian D. Roulstone and Jack J. Phillips. The business can be considered as positive if return of investment is less than five years. In TeliaSonera Finland business cases are calculated using an excel table which is used in all TeliaSonera business units. This excel will be utilized also in this Master’s thesis.

6.1.3 Return on Investment

The term return on investment is often misused, sometimes intentionally. In some situations a broad definition of ROI includes any benefit from the project. In these situations ROI is a vague concept in which even subjective data linked to the project are included (Roulstone & Phillips 2008, 203). According to authors the most common measures are the benefit-cost ratio and the ROI formula which this Master's thesis will focus on as well. Benefit-cost ratio compares the annual economic benefits of the project to the cost of the project. In formula form the ratio is

$$\text{BCR} = \frac{\text{Project Benefits}}{\text{Project Costs}}$$

BCR compares the annual economic benefits of the project to the cost of the project. A BCR value 1 means that the benefits equal the costs. A BCR value 2 indicates that for each euro spent on the project, two euros were returned as benefits (Roulstone & Phillips 2008, 204). BCR has not been used in TeliaSonera business calculations at all. However in this thesis it will be used as one tool to calculate business benefits.

Roulstone and Phillips writes that perhaps the most appropriate formula for evaluating technology investments is net project benefits divided by cost. The ratio is usually expressed as a percentage where the fractional values are multiplied by 100. In formula form, the ROI is

$$\text{ROI \%} = \frac{\text{Net Project Benefits}}{\text{Project Costs}} \; x \; 100$$

Net benefits are project benefits minus project costs. The ROI value is related to the BCR by a factor of one. For example, a BCR value 2,45 is the same as a ROI value of 145 percent.

In addition to the traditional ROI formula, other measures are occasionally used under the general term of return on investment. Payback period is a common method for evaluating capital expenditures. With this approach, the annual cash proceeds (savings) produced by an investment are equated to the original outlay required by the investment to arrive at some multiple of cash proceeds equal to the original investment. Measurement is usually in terms of years and months. As an example if the cost sav-

ings generated from a technology project are constant each year, the payback period is determined by dividing the total original cash investment by the amount of the expected annual or actual savings. As an example we can assume that the project expenses are 150 000 euros and annual net savings from the project is expected to be 60 000 euros. The payback period comes from the formula

$$\text{Payback period} = \frac{\text{Total Investment}}{Annual\ Savings} = \frac{150\,000€}{60\,000€} = 2{,}5\ years$$

The project will “payback” the original investment in two and a half years. This is easy to use but it has the limitation of ignoring the time value of money. (Roulstone & Phillips 2008, 218-219.)

6.1.4 Discounted cash flow

Discounted cash flow is a method of evaluating investment opportunities in which certain values are assigned to the timing of the proceeds from the investment. Basic assumption based on interest rates is that money earned today is more valuable than money earned a year from now. (Roulstone et.al 2008, 219.)

There are several ways of using discounted cash flow, but the most common one is probably the net present value of an investment. This approach compares the savings year by year, with the outflow of cash required by the investment. The expected savings received each year is discounted by selected interest rates. The outflow of cash is also discounted by the same interest rate. If the present value of the savings should exceed the present value of the outlays after discounting at a common interest rate, the investment is usually acceptable in the eyes of management. (Roulstone et.al. 2008, 219). In TeliaSonera Finland discounted cash flow will be calculated over five years with the discounted interest rate being seven percent.

6.1.5 Internal rate of return

The internal rate of return (IRR) method determinates the interest rate required to make the present value of the cash flow equal to zero. It represents the maximum rate of interest that could be paid if all project funds were borrowed and the organization had

to break even on projects. The IRR considers the time value of money and is unaffected by the scale of the project. It can be used to rank alternatives and can be used to make accept/reject decisions when a minimum rate of return is specified. A major weakness of the IRR method is that it assumes all returns are reinvested at the same internal return rate. This may have the impact that an investment alternative with a high rate of return looks even better than it really is, and that a project with a low rate of return looks even worse. (Roulstone et.al. 2008, 220.) IRR is rarely used as an indicator in investment calculations in TeliaSonera Finland and will be out of the scope of this master's thesis.

6.2 Process description

Most progressive companies, including Toyota, are exploring opportunities to create a truly lean enterprise, not only as concerns the manufacturing process but also in the areas of design, purchasing, engineering, finance and human resources (Morgan M James et al, 9). The authors of the book have concluded that lean way of working offers by far the greatest potential for a competitive advantage for any customer-driven company as a critical component in dealing with the many environmental challenges that all companies must now take into consideration. During the last few years also industry companies have been talking about customer focus and customer resource life cycle. Here customer service, entrepreneurship and increasing customer motivation as well as the moment of truth where the customer is comparing the service she or he is having to his or her expectations are taken into the evaluation. However these important factors do not necessary improve the customer experience. Process management will give concrete tools to improve customer experience and develop it deeper. (Hannus 1994, 35). Jouko Hannus describes Lean Management as light and flexible way of working. Lean means capability to produce more value for the customers with fewer resources. According to the definition of lean, all that does not add customer value has to be eliminated. (Hannus, 208). Lean principles have been described in the following way: Value added for the customer is a starting point for guiding the functions. The value consists of three factors: price, quality and time (delivery time, delivery accuracy, reaction time). Organizing the functions will be done from the customer point of view. Usually this means transferring from functional organization towards team and flow organizations where the functions adding value for the customers will be handled as one entity. In product development companies using lean the method will enable development of new products in 33% less time than the companies using traditional

methods would need. In addition a product will be easier to maintain and support. The lean method will also have an impact on product strategy and flexibility. A lean manufacturer will be able to produce and offer broad product portfolio and renew it often. By this way a lean manufacturer will be able to react quickly to customer needs and environmental changes. One of the cornerstones of the lean method is offering chain management, which consists of deep cooperation with subcontractors. As A consequence of this has been a multi-layer contractor structure where the partners are working very closely together with their subscribers. Very relevant factors are the questions of how committed the employees are and their capability to delegate the responsibilities downwards. According to the book, commitment of the employees has been enabled by key personnel starting up their own companies with strong support provided by the mother company. One of the corner stones in the Lean method is JOT storing principles, aspiration of the production, continuous product and production process improvements and customer driven quality management and principle related to that. (Hannus, 215-216.) That is also the case in TeliaSonera. There has been a project running called “TeliaSonera Lean”. It is in practise the lean way of working, but suitable for TeliaSonera’s own purposes. However, implementing the Lean way of working takes a long time, and after a huge reorganization process there has been delay in the implementation process.

The new process would increase the efficiency and ramp up the speed of migration. First of all there would be systematic area by area method in use. In practise some TDM circuits would be still remaining, but these can be handled by emulating technologies which can be considered as future proof technologies with IP/Ethernet support.

The new process would give the best benefits of lean way of working. TeliaSonera have on its own way of executing TeliaSonera lean which has been focusing a lot in visualization. This is the fundamental part of this Master’s Thesis process improvement part. The document “TeliaSonera Lean intro on visualization” describes the improvement loops which are: Voice of the customer, voice of the employee and correlating with continuous improvement. The lean method is based on Toyota Lean where Mister Ken Kreafle has stated as true lean definition:

> “The group by themselves use systematic problem solving to improve the work they do towards achievement of the company’s targets and goals when and only when existing company culture is the reason the activity is occurring”.

The process has to be visualized to be able to see the same picture, and as TeliaSonera Lean describes it: “We need to see the same giraffe”. This in practise means that if we can see the same challenges we will all start to work with the same objectives and solve the challenges together. The TeliaSonera Lean definition is that TeliaSonera will focus on visualization and on demand driven flows. Visualization is important, because human brains use visual information more efficiently and visualization makes it possible for everyone to see the same picture quickly. Decisions and information sharing will be facilitated (TeliaSonera Lean, 2014).

TeliaSonera Lean has also defined that all employees should strive towards a continuous and connected flow with focus on end customer need (TeliaSonera Lean, 2014). This is the vital part of making TeliaSonera a successful company with superior customer experience. This means that the migration process target has to be changed to focus more on customers and to improve the process from the customer point of view.

The researcher will investigate the current situations of current migration processes. The processes in the scope are: The technology migration process, the pole dismantling process and the 4G planning process including how these processes work currently together and support each other. The target is to understand if it would be beneficial for TeliaSonera Finland to have one migration process covering all the three separate processes mentioned above.

6.3 Life Cycle Management

Authors Benhoussan & Fleisher are stating in their book Strategic and Competitive Analysis, that S-Curve analysis integrates technological change into strategic planning. This tool for managing technological challenge allows the analyst to compare the limits of the firm’s current technologies to that of competing and potential technologies in order to decide upon which technologies to base its future strategy as well as when to deploy new technology. The concept of logistical functions, or S-curves, has been applied to studying technological change since decades ago. These diffusions models attempted to explain the speed at which new technology is substituted for an existing technology. The speed of technological diffusion in an industry depends on the number of firms that have adopted it and the number of firms still employing the old technology. The diffusion models have three distinct phases that manifest themselves graphically

into the classical S-curve shown in the figures later on. The theories main focus is on time as the dependent variable and on speed of diffusion is more relevant for industry-level analysis. Product Life Cycle (PLC) has been introduced to make diffusion theory more relevant for decision making at company level. (Benhoussan et.al., 381.)

6.3.1 Product Life Cycle Model

The product Life Cycle Model consists of four areas. Introduction is the first phase when introducing a new product or service into the market. First mover consumers begin to purchase. The second phase is growth when consumers begin to purchase the product and sales are booming. The third phase is reached when the majority of consumers have adopted the product, repeat sales dominate. Sales growth reaches its maximum and begins to decline. The fourth phase is when for whatever reason sales begin to decline and eventually tamper to a much lower level or zero. (Benhoussan et.al., 382.)

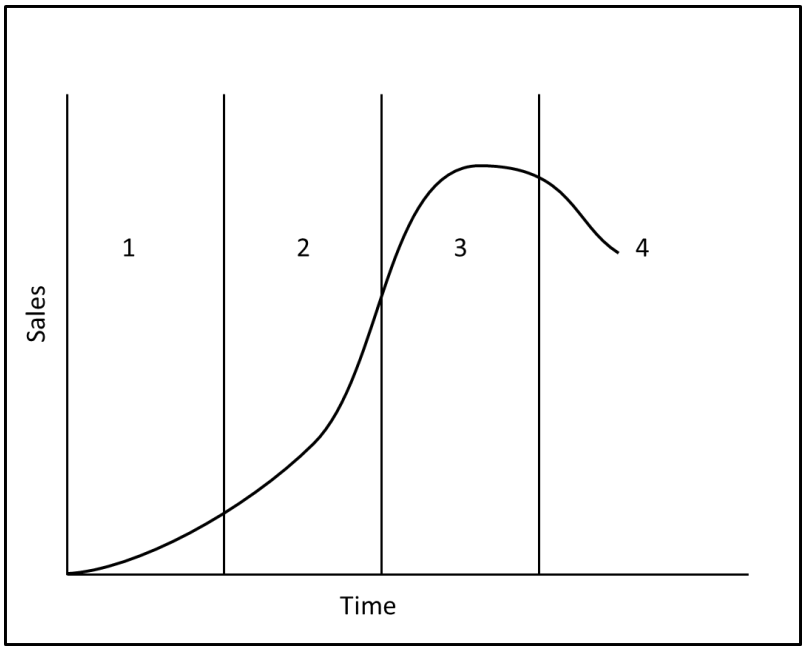


Figure 12. Product Life Cycle Model (Benhoussan et.al., 382.)

The products running on top of old fixed technologies have reached the 4th phase already some time ago. However due to complexity of the underlying technology, it has been very difficult to calculate, if the products are still profitable or not.

6.3.2 Technology Life Cycle Model

The technology Life Cycle model is divided in four different phases. The first phase called “Fluid” is when consumer needs are not fully defined and the focus is on product innovation by very entrepreneurial and flexible firms. Transition is the second phase when innovations begin to become standardized, resulting in the transition to a focus on process improvements with an increase of structured firms. Competition becomes based on price and low costs. The third phase called “Specific” has been reached when the predominance of process over product innovation becomes more rigidly entrenched. Firms become even more structured. Fourth, the mature phase has been reached when product innovation ceases as the industry becomes more a commodity. (Benhoussan et.al., 382.)

At the moment TeliaSonera Finland is in the second phase as regards old fixed technology migration. The challenge has been acknowledged widely in the organization. The evidence for this is that migration work has been started to be considered as one entity. This means that the migration process has to be taken into account from technology point of view, but also from products and services, mobile base station build-out point of views and from pole dismantling point of view. The S-curve concept explicitly addresses the need to incorporate technology into strategic planning. (Benhoussan et.al., 385.)

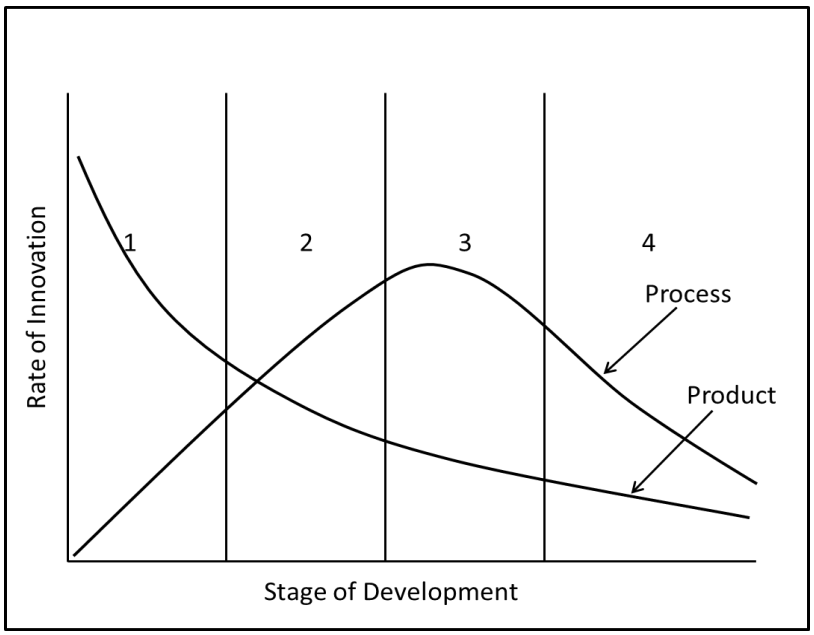


Figure 13. Technology Life Cycle Model (Benhoussan et.al., 385.)

Every technology has a natural limit to the benefits it can generate (Benhoussan et.al., 385.) From old technology point of view the limit has been reached. Network elements are end of support which means that the network elements are at the end of their life cycle. The capacity provided by old fixed technology is not meeting today's requirements with traffic growth.

As a migration strategy point of view and how to manage the risk regarding end of support platforms. When a platform goes End of Support (EoS), then the risk immediately rises in the network. Security problems and traffic affecting bugs could appear and TeliaSonera Finland would not be able to do anything about it. The customer would suffer from bad quality and the market value as a secure and reliable network provider would start to decline. At this stage TeliaSonera Finland could not introduce new functionality that, in the end, are the base for new or enhanced services for our customers.

When a platform is so old that TeliaSonera Finland cannot even get spare parts from the vendor anymore, the risks are rising even more. The number of platforms without any support and/or normal spare part handling is growing every year. The situation is becoming a serious problem, not only to be able to produce a minimum level of quality but also to be able to produce the future network and services in a cost effective way.

It is good to keep in mind that TeliaSonera Finland have not migrated all legacy platforms yet, and the first generation of IP platforms are without support and normal spare part management – and now also the second generation of IP platforms are starting to get End of Support. The following Figure is illustrating the increase of risk level when platforms are at end of support and when would be the most optimal phase to start the migration.

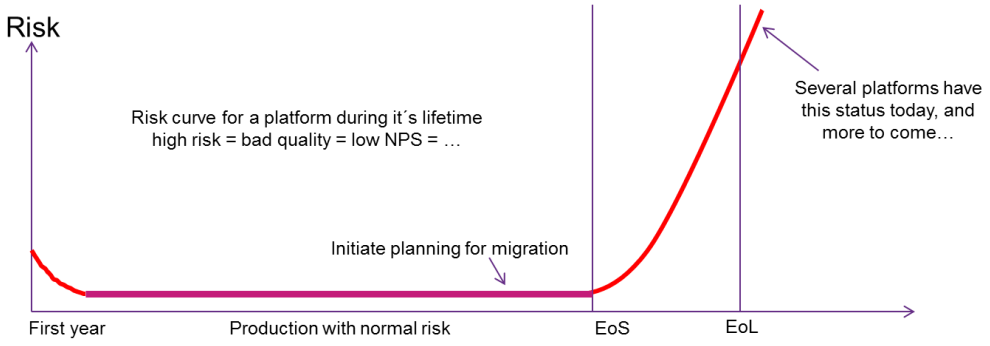


Figure 14. The most optimal phase to initiate migration

The consequence of postponing old fixed network migration with disappearing competence can be seen in Figure 8. In 2008 TeliaSonera Finland had approximately 61 000 old network elements in production. During that year there were a bit more than 8 300 faults. Out of that 3 441 fault cases were sent to the field technicians. By the end of 2014 the number of old network elements were reduced by 18 686 down to 42 315. However the number of equipment faults were increasing by 375 up to 8 683 faults and out of these fault cases sent to field technicians were increasing by 1 885 cases up to 5 326.

7 Execution of the migration project

Technical migration in the networks has been on TeliaSonera Finland's agenda for the last ten years. Required investments have been postponed year after year. The current situation in the networks is that we have an increasing amount of end of life network elements in the production. Devices are dismantled from the network whenever those are emptied from traffic (TeliaSonera internal presentation, Tahvanainen 2014). How does migration work support the quality target? How big a risk is this for customer experience point of view? What will be the impact on customer experience on long term? At the moment TeliaSonera is running two parallel networks, and both of them are driving costs, both capex and opex. The old network is more driving operational expenses than capex, but at the same time the old network is a risk. Some of the net-work elements are end of repair services, which means that if a network element fails, we have to provide the needed spare part ourselves. This is driving internal opex. The main problem for TeliaSonera is that there is no systematic way to handle end of life technologies.

7.1 The scope of the project

TeliaSonera Finland have planned and built different kind of service platforms for voice- and data-services since 1980. These systems have worked very well for the needs of our customers but now the internet based (IP) services have increased dramatically and therefore customers' behaviour has also changed. Consequently, manufacturers are changing their focus into new services and their support for the old fixed network systems is weakening at the same time. Another reason for this kind of migration is the

fact that the services can be produced nowadays cheaper than using old technologies. Also, when time goes forward TeliaSonera Finland may have more and more problems to keep the amount of the spare parts at the needed level.

TeliaSonera Finland started different kind of tasks relating to the old fixed network migration in 2007. However old fixed network migration has been managed as a project since 2011. The results from previous years can be seen in the attached document below as well as the plan for 2014.

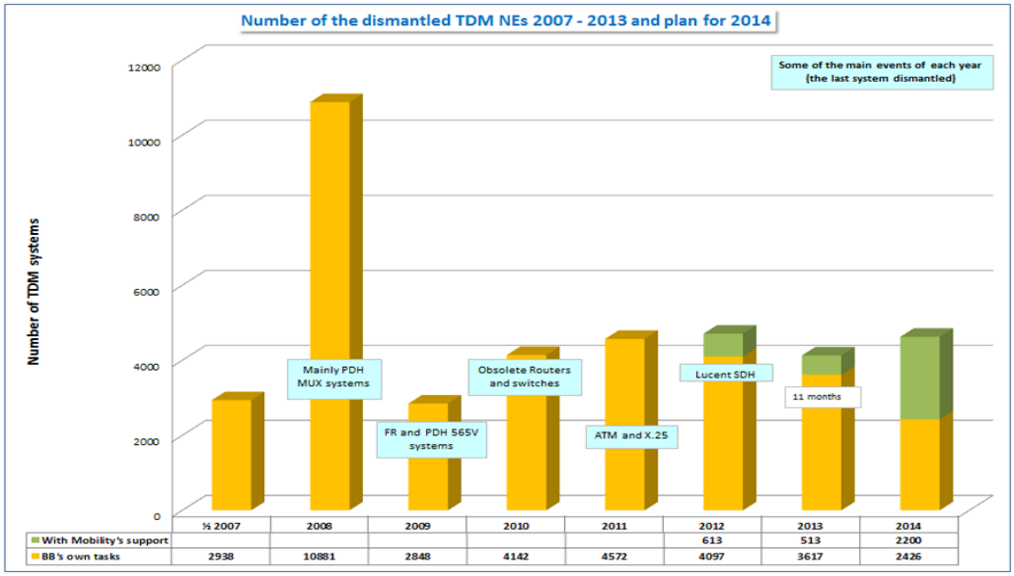


Figure 15. Old fixed network elements in TeliaSonera Finland's network (Kuitunen, 2014).

The main purpose of the project is to support TeliaSonera Finland's transformation process to future proof and cost efficient service network. This means that the owner of the Finnish business have to change the customers' existing on old services by offering them new products (product migration) or keep their current services as they are and only move the connections from old systems to new systems. Within TeliaSonera there is also tight co-operation with the business units. Another important reason is the fact that unless TeliaSonera had actively re-arranged the connections or optimized systems the production cost per customer would have increased a lot. This Master's thesis will take one defined area in the old fixed network as a pilot area to illustrate possible benefits by modernization of the network by calculating the business case as well.

One of the main goals for 2014 was to dismantle 150 old fixed network elements, and three larger digital cross connection systems. The focus should be on the old systems

which are the most risky from operation and quality point of view. One of the key activities is to secure the spare parts. Old systems in the cables which are installed next to the railways, should also be taken into account and keep in mind the cost-effectiveness (synergy with the other projects, minimize the number of visits to the sites). By analysing the old fixed core network and network elements in area, TeliaSonera Finland tries identify those capacity connections for which migration priority should be raised. The migration work should be supported by versatile analysis (utilization level of the systems, recycle equipment, evaluating the future trends, development of the faults and so on). On the mobile network, 2G swap will be in a big role and therefore it needs to be taken into account when planning activities on old low speed (2Mbit/s) connections. TeliaSonera Finland has to do the activities without causing any serious defects to the network management system in use.

The asset registers of these old systems have been updated during Q3 2014 and the needed scrapping documents have to be prepared for the implementation of the write-downs. The plan was to migrate and dismantle at least three large Digital Cross Connection network elements (DXC).

The responsibility of the Finnish business owner is to contact old fixed line telephony customers in 190 concentrator areas and by this way supporting our objectives to dismantle 220 concentrators in 2014. The customer base has been analysed by BUF and they have got permission from Business to Business (B-to-B) and Business to Consumer (B-to-C) units to select just those concentrators under migration activities. In the selection phase, we have used different kind of analysis methods to select the right concentrators on basis of their cost-efficiency as well as from the customer base point of view.

7.2 Researcher’s role in the development project

The role of the researcher is to set guidelines and create a business case calculation based on the evaluation of the target geographical area in Finland. Researcher has held a number of meetings with the informants about the pilot area and discussions about how the cost versus benefits calculations should be done to be as accurate as possible.

Researcher will also analyse the current process and create suggestion of Lean way of working regarding old fixed network migration. Lean in this context can be considered to mean that taking all new technologies into account will support old fixed network migration.

7.3 Project time schedule

Project analysis and preliminary planning will be made by one of TeliaSonera Finland's subcontractors during autumn 2014. The plan for the pilot will be created by the end of Q4 2014 and execution of the pilot project will be done during Q2-Q3 2015. The results of the actual migration execution will be out of the scope. Analysis of the project outcome and agreeing about the next steps will be done by the end of March 2015.

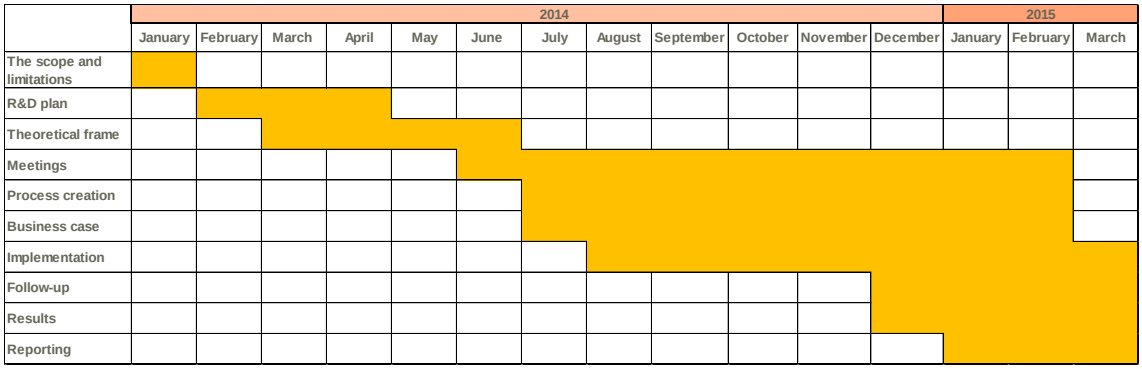


Figure 16. Time schedule for the pilot project.

The time schedule has been postponed due to major organisational change within whole TeliaSonera and also due to change in the role and responsibility of the investigator.

7.4 Project organization

The project organization consisted of one external resource working for one of the subcontractors TeliaSonera Finland use for detailed network planning. The rest of the project resources were permanent TeliaSonera Finland employees consisting of two business controllers and five technical specialists and one project manager. The structure of the organization was following normal project structure. A project steering group was not required because of the small size of the project.

The project was followed up by regular meetings and reported on a weekly basis through the line organization. The final report will be done by the researcher according to project and research results.

7.5 Research interviews

Interviews can be structured or non-structured. A structured interview means work to be done in advance with research questions and problem description. The purpose of this is to secure that during the interview in beforehand set questions will be asked and discussed. (Anttila 2006, 196.) By interviews the aim is to collect material to be able to conclude in a reliable way the research phenomena. (Hirsjärvi et al. 2010, 66.)

The interviews were held by the following meeting procedures. The informants were network planners and technical specialists. Economic research interviews were held by with two business controllers. The meeting agendas were sent to the informants in advance, so they had time to read the items through and think the situation through before the meetings.

8 Research results

8.1 Results of SWOT –analysis

Strengths: • High reliability and availability implemented by protection methods • Large network coverage • Well understood, long experience • Profitable • End-to-End remote management • High security for customer (customer dedicated connection)	**Weaknesses:** • Some equipment are very old technology • End of vendor support platform by platform (EoS) • Older equipment support only small capacity • Old fixed network is not efficient • Limited development
Opportunities: • To find a correct time to shutdown services • To find a new way to run profitable services a longer time • Equipment based on new technologies simplifies network structure and reduces costs • Create more efficiency by developing a new process for migration	**Threats:** • Product migration is too slow • Customers and revenue may decrease because of product migration • Fading know-how • Increasing failure rate • Lack of spares • End-to-End management may be lost • Network quality may decrease

8.1.1 Strengths and opportunities

- High reliability and availability implemented by protection methods
    - Many customers using old fixed network services trust the technology even today. This can be seen among operator customers of TeliaSonera Finland.
    - Protection methods guarantee high availability for the customers.
- Large network coverage
    - Old fixed network is nationwide covering rural areas as well.

- Well understood, long experience
    - The knowledge of the technology is mature due to extremely long experience
- Profitable
    - Related depreciations have been done. Mainly maintenance costs needed. Some investments done for securing the spare parts.
- End-to-End remote network management
    - Efficient end-to-end network management system guarantees fast incident reaction time and fault management tools.
- High security for customer (customer dedicated connection)
    - Circuit switching is secure end to end connection for the customers.
    - No same security threats as in the new technologies and protocols

8.1.2 Weaknesses and threats

- Product migration is too slow
    - Could lead to mandatory investments to keep legacy services running
    - Could be slower than expected because of CAPEX limitations
- Customers and revenue may decrease because of product migration
    - IP products are not so profitable as legacy products?
- Fading know-how
    - Average age of personnel is getting higher and the persons are close to retirement
    - Latest redundancy rounds have led to early know-how lost
    - Old technologies and protocols education reduced in universities and polytechnic
- Sudden increase in failure rate
    - Old equipment
    - Low know-how has led to increased failure repair times and unnecessary usage of spares
- Lack of spares
    - Number of “End of repair” (EOR) platforms will increase
    - Mandatory to recycle units to fulfil spare needs. More control needed to monitor spare usage and testing requires manpower.

- End-to-End management may be lost
    - Network provisioning becomes slower
    - Fault localisation more difficult thus service quality decreases
- Network quality may decrease
    - Can lead to customers dissatisfaction and lost customers – decreased revenue

8.2 Research results

Research results will focus on two main areas in line with the main research question "Does old fixed network technology migration produce return on investment less than five years for TeliaSonera Finland?" This leads to business case calculation including savings achieved by reducing number of network elements and by that reducing power consumption and other operative expenses. The results describe also the new implemented process to support efficient technology migration. Efficiency and simplicity in the production network will be presented by decreased number of network elements.

8.2.1 The result of the business case

The result of the business case is based on assumptions, to some extent. Exact figures are visible in appendix 3 which has been labelled as confidential material. Geographical area 1 investigated in the Master's Thesis consists of hundreds of network elements. Re-investing the network would need 665 850 euros. Re-building and restructuring the network would release 520 network elements. Most of the elements have reached end of life status. Average annual net savings on reducing energy consumption in case one would be 116 485 euros. In addition there would be savings on fault cases. The figure is based on the number of fault tickets during 2013. There were 20 fault cases in area 1. One fault case cost is 1 500 euros. This equals in total 34 890 euros. This can illustrated as benefit cost ratio (BCR):

$$\mathrm{BCR} = \frac{151\,375€}{(665\,850€:12)} = 2{,}73$$

BCR compares the annual economic benefits of the project to the cost of the project. A Benefit Cost Ratio of 1 means that the benefits equal the costs. A BCR of two indicates that for each euro spent on the project, two euros were returned as benefits (Roulstone

& Phillips 2008, 204). When using BCR you have to divide the one time investment by twelve in this case, because achieved savings will be gained over one year. As a conclusion economic benefits are clear because every invested euro would bring 2,73 euros back as benefits.

From the company's point of view a more interesting fact is to calculate the payback period, which would be in this case:

$$\text{Payback period} = \frac{\text{Total Investment}}{Annual\ Savings} = \frac{665\ 850€}{151\ 375€} = 4{,}39\ years$$

When looking at the number of network elements, geographical area one consists of 520 old fixed network elements. After migration there would be 180 modern network elements in production. This reduction of 340 network elements equals a 66 per cent reduction. This also brings simplicity in the networks and clear savings for TeliaSonera Finland.

Another geographical area which has been analysed is a bit larger. There will be 773 network elements dismantled. This would bring approximately 201 000 euros savings annually by lowered energy consumption. On top of that, there would be savings on fault cases. The figure is based on the number of fault tickets during 2013. There were 27 fault cases in area 1. One fault case cost is 1 500 euros. This equals in total 49 112 euros. In addition there would be an investment requirement of approximately 1 000 000 euros. Benefit cost ratio would be in this case:

$$\text{BCR} = \frac{250\ 112€}{(1\ 000\ 000€ : 12)} = 3,\ 00$$

The total investment of one million euros has to be divided by twelve also in this case, because achieved savings will be gained over one year. As a conclusion economic benefits are clear because every invested euro would bring 3,00 euros back as benefits.

When looking at the number of network elements, geographical area one consists of 773 old fixed network elements. After migration there would be 200 modern network elements in production. This reduction of 573 network elements equals a 74,2 per cent reduction. This brings simplicity in the networks and clear savings for TeliaSonera Finland.

Calculating the payback period, which in this case would be:

$$\text{Payback period} = \frac{\text{Total Investment}}{Annual\ Savings} = \frac{1\,000\,000€}{250\,112€} = 4{,}0\ years$$

From a business case point of view there is a good business case in place especially in geographical area 2. Annual savings are based on average savings in relation to real number of dismantled network elements. End customer revenues and extending the customer life cycle has not been taken into account. The reason for this is that it was impossible to get reliable revenue information from the systems, based on a geographical area.

The third area which will act as a pilot area is much smaller than these two large geographical areas. The area consists of 97 sites and 402 old fixed network elements. There are ~5200 broadband and more than 1800 old fixed phone subscribers. The area consists of 98 mobile base stations including 57 radio links. In the area exist 14 modern future proof nodes, 70 broadband network elements, 3 old fixed network element and 34 other nodes. The following Figure shows the current situation from customer access point of view.

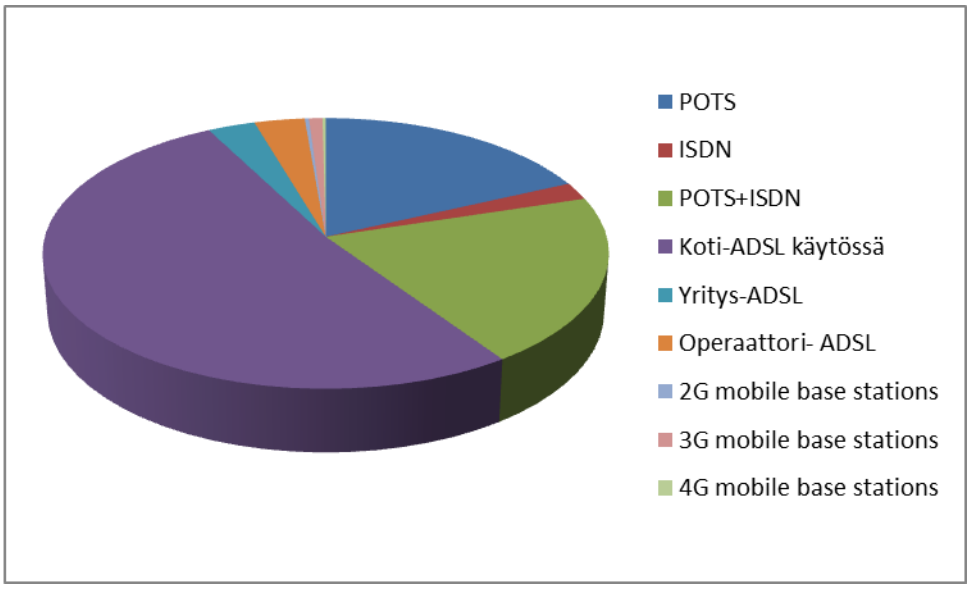


Figure 17. Technologies in use in the pilot area

The chart illustrates that the most dominant technology for broadband is ADSL. Old fixed telephony (POTS) is still widely used for voice communication in parallel with mobile voice. The area also has a significant number of ISDN users. ISDN can be used both for voice communication as well as for broadband and/or Internet access. However ISDN can be considered end of life technology as well.

When calculating the business case, needed investment is based on real network planning with aim to replace all old fixed network technologies in the area. This way TeliaSonera Finland would renew the network technology and increase network capacity significantly. Savings are based on energy savings per dismantled network element as well as reducing vendor support costs and reducing the number of fault cases in the area. When replacing old fixed technologies in the area, the calculated annual savings are 62 608 euros. The needed investment for replacing old fixed technology is 153 516 euros. The cost consists of construction and site planning, implementation and dismantling costs, needed material and investments for new technology. New fiber construction cost is approximately 40 per cent of the total cost.

To be able to take full benefits of the migration, 4G mobile base station build-out has to be in line with migration activity. 4G will support migration in the areas where fixed lines are not profitable and fixed access technologies have reached end of life cycle phase. At the same time the area has to be evaluated also from a pole dismantling point of view. By this way of working TeliaSonera Finland would gain most benefits from its

investment, but also from a cost saving point of view. Maybe the most important thing by this way of working would be reducing the churn and optimize customer satisfaction.

$$\text{BCR} = \frac{62\ 608€}{(153\ 516€:12)} = 4,\ 89$$

When using BCR you have to divide the one time investment by twelve also in this case, because achieved savings will be gained over one year. As a conclusion economic benefits are clear because every invested euro would bring 4,89 euros back as benefits.

Calculating payback period, which in this case is:

$$\text{Payback period} = \frac{\text{Total Investment}}{Annual\ Savings} = \frac{153\ 516€}{62\ 608€} = \sim 2{,}5\ years$$

The calculation does not include savings achieved by fault fixing and decline in repair costs or savings achieved by reduced vendor support costs. Based on an assumption of average cost per network element, savings could be potentially 88 576 euros in the area in question. However the figure is based on assumption and left out from the business case calculation. If these costs would be taken into account, payback time would be approximately one year.

When looking at the number of network elements, geographical area three consists of 253 old fixed network elements. After migration there would be 63 modern network elements in production. This is reduction of 190 network elements equals' 75 percent reduction. This brings simplicity in the networks and clear savings for TeliaSonera Finland.

As a summary we can conclude based on the analysis made on the three geographical areas in Finland:

Table 2. Reduction of network elements by migration activities

Summary of the migration benefits				
	TDM Network Elements	**IP/Ethernet Network Elements**	**Reduction of Network Elements**	**%**
Geo.Area 1	520	179	341	66%
Geo.Area 2	773	200	573	74%
Geo.Area 3	253	63	190	75%

It is evident that by technology migration TeliaSonera Finland will increase efficiency and simplicity in the production network. Reduction of the network elements in all cases is more than 65 per cent. Based on the researcher's own experience, the reduction is massive.

The benefit Cost Ratio looks as follows:

Table 3. Summary of the BCR calculations

Summary of the benefit cost ratio (BCR)			
	Geographical Area 1	**Geographical Area 2**	**Geographical Area 3**
Benefit Cost Ratio	2,73	3,00	4,89

The benefit cost ratio describes how much you will gain business benefits with every invested euro. This could be one more tool for the management to support decision making within TeliaSonera Finland.

From the return on investment point of view the conclusion is the following:

Table 4. Summary of the ROI calculations

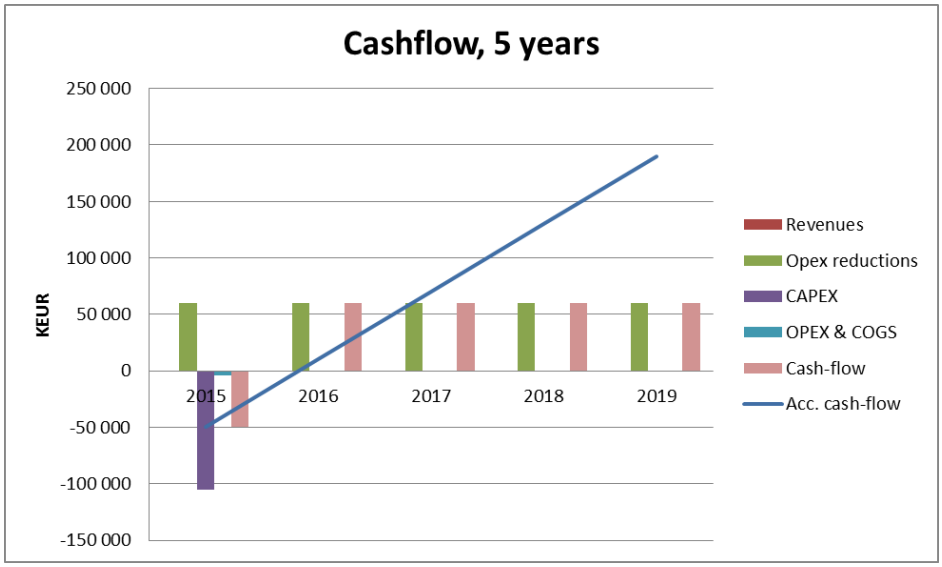
Summary of the return on investment (ROI)			
	Geographical Area 1	**Geographical Area 2**	**Geographical Area 3**
Return On Investment	~4,5 years	~4,0 years	~2,5 years

Business case calculations are very promising if we think about this particular part of the networks which is the core and aggregation parts of the network. In the core you can assume that the life cycle of the network elements are more than ten years. In the aggregation part of the network you can assume that the life cycle is more than eight years.

8.2.2 Discounted cash flow

Discounted cash flow is widely used in TeliaSonera's business case calculations. In this case discounted cash flow is calculated only for geographical area three because that area will be the pilot area for execution. The calculation period is five years. The calculation interest rate is seven per cent and the financial interest rate for debit is 0,75 per cent and for credit it is 3,50 per cent. The costs are based on real network planning to make geographical area three free of any old fixed network technology. The capex need is 105.611 euros and the internal opex cost is 4.000 euros. Opex reductions will be 59.887 euros annually achieved only by energy consumption reduction only. The following table illustrates the situation over a five year time period.

Table 5. Cash flow over five years



Revenue and churn impact has not been taken into account, but it would make the cash flow calculation even better. However, it is evident that technology migration would bring clear savings for TeliaSonera Finland even in a short term. A business benefit in terms of opex reductions occurs on a yearly basis. This has an impact on accumulative cash flow which makes the business case extremely attractive. Detailed profit and loss impact calculation can be seen in an appendix 2.

8.2.3 The result of the process implementation

The actual process has to follow TeliaSonera's general processes which are the Technology unit's responsibility. The processes are resource life cycle, resource implementation which includes also network planning as well as service assurance and operations. Resource in this context means network resources. These processes are part of TeliaSonera's processes defined as production. This has been the frame when developing a migration process for TeliaSonera Finland's purposes. Resource lifecycle takes care of technology life cycle management and gives input to the resource planning process which will create an investment proposal and they create a plan for the network including work orders to sub-contractors. Whenever work has been completed, it will be handed over by the planning resources to the service assurance and operations process. They will supervise and monitor the network. The migration process will follow this process on a high level. The high level process description is below:

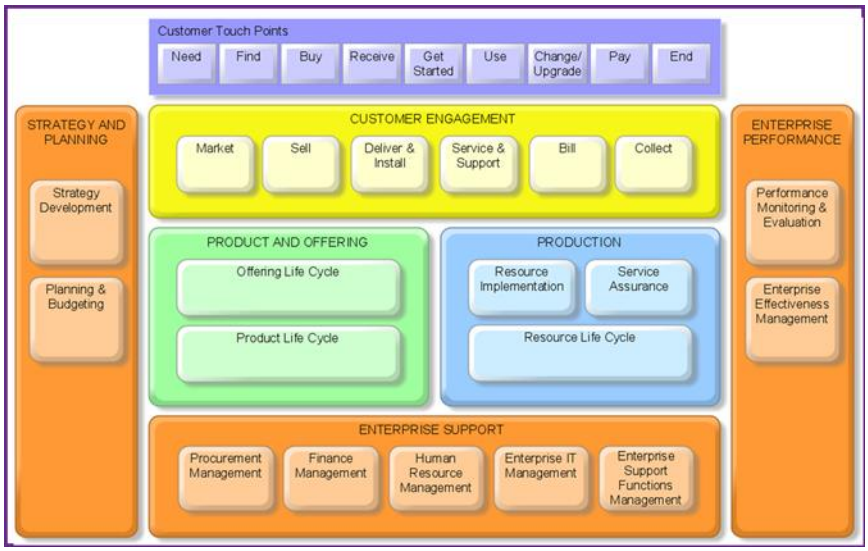


Figure 18. TeliaSonera Process Map (TeliaSonera intranet, 2015).

The process map has a good alignment with the Enhanced Telecom Operations Map (eTOM) developed by Telecommunication Management Forum. Processes based on ITIL (IT Infrastructure Library) can also reside inside the different processes.

The process standardization in this case means that the creation of area based business case calculation has to be taken into the process. Based on this Master's thesis it has been evident that there are differences between the areas. Therefore it is necessary to create a business case each time when planning a migration in one geographical area. Another clear improvement will be in process implementation: to add customer in the picture by using a lean method. It is one relevant part of the lean method to combine customer orientation and cost efficiency. (Hannus, 219.) To be able to have a complete and successful migration process 4G base station planning and implementation have to be taken into account. When taking one area under planning, all three major streams have to be considered at the same time. Network element migration and new IP based technology implementation, 4G coverage planning and possible pole dismantling. By this standardized process way of working TeliaSonera Finland will save money and cost but also reduce churn.

The process should be developed in a way that the migration initiative begins in Products and Services. This means that the sales forces have to be activated and meet the customers by offering new IP based products and services. After the new solution has been found and agreed the way forward together with the customer product migration can be executed. As an outcome there would be getting rid of old fixed network based

services, offloading IT systems and reducing old network traffic. By this way of working TeliaSonera would not need to invest in new technology as much as without efficient products and services migration. The migration flow would look like this:

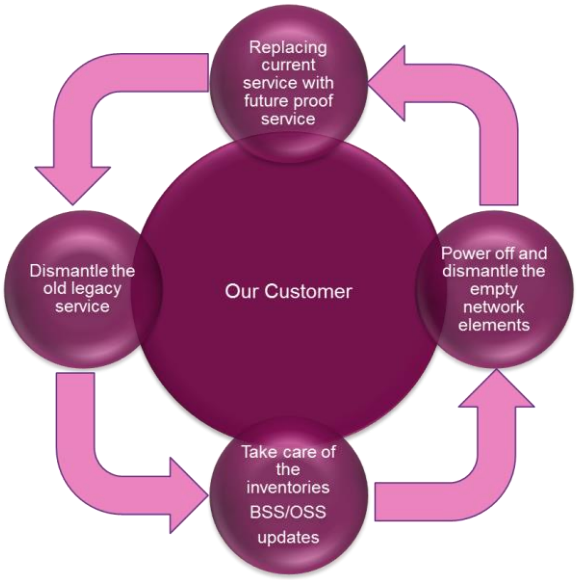


Figure 19. High level description of the migration cycle

The impact would be that the most efficient way of working would be to establish a team working only with migration. The team would consist of sales forces, product and services representative, customer operations and IT engineers.

The migration work flow has been described in details and consists of seven main parts. The flow starts with the architecture process. There the big picture has been defined and megatrends and the future technology development are followed. Architecture should give preliminary estimates for budget over three to five years. In the preplanning process actual evaluation will be done, what should be done and what should not be done. Before handing over the task to the next phase, there is a decision point for the actions to be executed and to ensure the budget. After that, actual planning will be started with detailed network planning and securing resources from the subcontractors. Deployment will take over the task and they will build out replacing capacity, if new replacing technology is available. Deployment has authority to migrate the customers from old technology to new technology when the end product remains as-is. After safe and sound customer migration the dismantling process will be executed and old technology will be taken out of network management. After that IT systems and network elements will be removed from technical sites and the deployment organisa-

tion will make sure that old technology will be recycled properly. If there is no new replacing technology available, the technology is question will be moved to maintenance mode, consisting of services assurance and securing spare parts. The migration process has been described as follows:

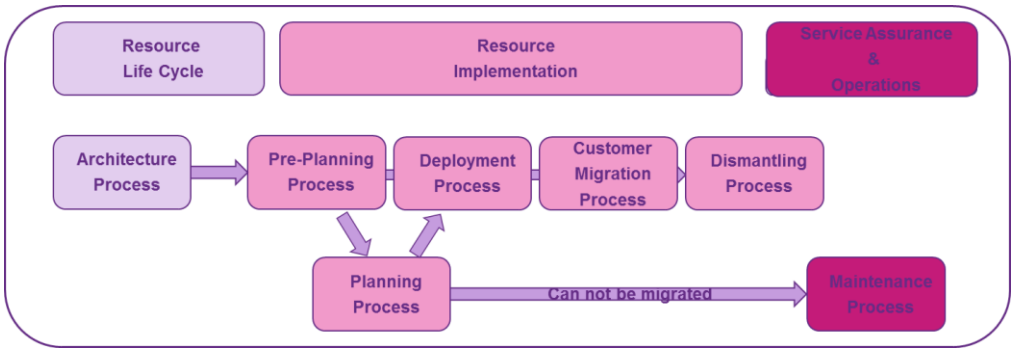


Figure 20. Workflow mapped to the main processes

In Figure 19 the main processes are indicated with different colours. Workflow is described below the processes. Colour is indicating which main process, a workflow belongs to. The detailed process and workflow description can be seen in appendix 1.

The workflow which is part of the resource implementation main process, has to evaluate a certain area from all technologies point of view and has to make the final decision based on the most optimal solution from the customer's, but also from TeliaSonera Finland's point of view.

On the level described in Figure 19 the processes and workflow are applicable also for other technologies than old fixed network technologies. The process will be tested in practise when technology migration on one of the geographical area will be executed. The results cannot be reported in this master's thesis mainly due to time constraints. The process itself has to be developed continuously to be able to maintain the lean approach.

8.3 Research validity and reliability

Basic expectation when looking at reliability is sufficient documentation. However documentation will not help if used research methods are not correct and if the methods

are not used in a right way. One should choose correct methods based on the research problem and the research question. (Kananen 2010, 144.)

Kananen also describes that reliability and validity are measuring the quality and reliability of the research. The reliability means consistency of the results and validity means that researcher is investigating the right things. Validity describes the target of the measure and the measures which will be used. Reliability describes and combines the used measures and the outcome of the measure. (Kananen 2014, 146-147.)

The reliability of this research has been secured by using a number of information sources. Reliability for the process development and the business case has been reached by having a number of meetings with technical specialists and business controllers. A lot of relevant books about technology related projects and process improvements have been read. Own experience and observations during the process improvements have been used. The most important thing has been having structured interviews together with project team members and business experts and business controllers. The simplest way of proofing research reliability is to utilize multiple sources when looking after support for the arguments and interpretations. (Kananen 2014, 152.)

Validity will be more challenging because in qualitative research there is always room for different interpretations. This research has used different channels and sources for accurate information which means that a number of interpretations have been used as synthesis of multiple sources. Validity can be reached by using another researcher to analyze the results. If the outcome and results will be the same with both researchers, it will increase the validity. (Kananen 2014, 153.) However, the business case will vary depending on the geographical area and the current network design and on how much fiber infrastructure is already in place. If only one geographical area will be taken into account the results are valid because the business case calculation figures can be considered as the facts and cannot be changed. The results are also reliable because three different areas were analyzed and in all cases the business case was positive.

9 Conclusions

Technology migration as a whole is a very complex and hard to judge environment. First of all when considering network technologies, you should think industry mega-trends as a starting point. Megatrends that can be seen today that are, that 2G mobile is migrating and changing from old fixed network technology to modern and cost efficient technology automatically by the end of 2016. Another trend is life cycle of old fixed phone lines is declining and a third trend is that mobile 4G, which is in practice mobile data, will partially replace fixed broadband. The megatrends are showing that there is no need to execute massive network migration but execute the migration in the most suitable areas and by that secure the spare parts. However when building new back haul connections for mobile 4G, the whole area should be evaluated and planned from mobile, fixed and pole dismantling points of view. From the business case itself it is evident that there is a positive business case when this kind of area evaluation needs to be done and executed. Today the existing organization structure is supporting this approach and the project is covering network migration and 4G build-out but also pole dismantling is covered by one project and project team. Previously these were handled separately in different projects, which led to sub optimizing and inefficient spending of financial assets.

From a costs point of view saving initiatives during the past few years has caused that required migration has been postponed and in some cases halted completely. By this way of working the consequence is that there is a backlog of migrations that are more and more difficult to handle. This is because a migration does not only require capex/opex, but also internal manpower and resources from subcontractors.

The graph below (purple) shows a normal way of handling migrations when it comes to allocation of capex/opex. Migrations must be a normal way of working and budgeting to be able to reach the long term targets of better network quality and a cost effective network and organisation.

The graph below (red) shows the status today. TeliaSonera Finland has been every year postponing more and more required migrations, making the long term migration targets more difficult to manage and with that high risk for lower quality in the production network.

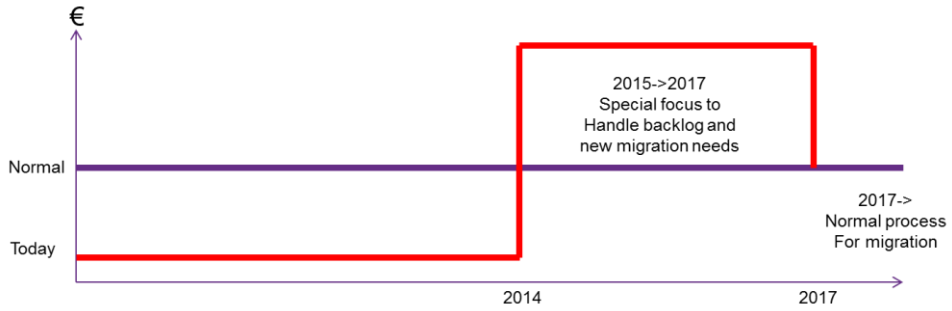


Figure 21. Focus on reducing backlog of migration needs

When looking back to the three focus areas, it is evident that in all of these three investigated geographical areas, return on investment will be less than five years. Reduction of the network elements in the production is significant and the process has been implemented to cover both fixed and mobile network planning. However the competence on individual level is still split between two areas, but should definitely be developed and educated that one individual network planner can handle both fixed and mobile technologies. For technology life cycle management it is crucial to follow vendor specific roadmaps and invest to new technology early enough. This has been illustrated in Figure 13.

9.1 Research evaluation

The research was quite challenging to work with in a changing environment. Large scale organizational changes during spring 2014 and changes in my own role and responsibility caused some delays to the research. However the importance of understanding both technical and economical environments was still on the table. Organizational change meant in practice that both fixed and mobile network planners were set in the same organization. That set a clear demand for process development quite naturally and required resources were available. Technology life cycle management itself was not investigated itself, but I believe that the importance of regular re-investments is mandatory and should be on the agenda on a yearly basis. From the researcher's point of view it was very motivating to work with all employees who were part of the research.

When writing this the organization in TeliaSonera Finland will support the way of working described in this thesis.

Most importantly, the answers were found to the research questions.

1. Does technology migration enable business benefits for TeliaSonera Finland?
   As described in the research results, the evidence in all investigated areas, two larger and one smaller area would give business benefits and attractive return on investments

2. How to find the optimal time for migration?
   Finding an optimal time for changing old technology to new is very much dependent of the vendors' life cycle roadmaps and support plans. Therefore it is very important for operators to follow-up development and secure that money available in the budgets on a yearly basis. However, it is crucial for the operators continuously execute analysis of the network faults.

3. How does return on investment look like in those selected geographical areas?
   Return on investments looks very good, since in all three areas meets the result meets the target to have less than five years return on investment. Based on the fact, it would not be hard decision for the management to approve even more aggressive migration. The smaller area has already been ordered for implementation from the subcontractor. TeliaSonera Finland have to wait for a couple of months, since the ground is still frozen, which makes fiber digging impossible.

4. How to develop profitable network technology life cycle management?
   Based on the findings in this thesis, profitable technology lifecycle management can be achieved by efficient lifecycle and investment management. A crucial part is also an efficient process covering all technologies from a network planning point of view and an area based approach whenever technology change is due.

9.2 Theoretical framework aptitude for the research

In the theoretical part main literature was used in the areas of processes and project management, investment and economics management as well as strategic thinking. From the researcher point of view strategy is one of the corner stones and renewing old environment is one of TeliaSonera Finland's strategic key topics. The biggest challenge was to find broad enough catering of technology lifecycle management literature. Most of the books were written from information technology (IT) point of view. However one of the books was very good and gave solid background for technology lifecycle and investment management.

9.3 Proposals for the next steps

The network planners within TeliaSonera Finland should begin to learn new areas of technology domains, to be able to get the best benefits out of the common process developed both for fixed and mobile network planning. The reason for this is that area based technology change from old technology to new, would be more efficient if one network planner would have knowledge both fixed and mobile networks and technologies. This is one of the next areas to be investigated further.

The second area that should be investigated is benefit cost ratio, if it could be used in parallel with return on investment and discounted cash flow calculations. This because the benefit cost ratio describes really well how much the company will get back as benefits.

As a follow-up the author suggests that the technology change in geographical area 3 will be evaluated during autumn 2015 right after the execution has been completed. This needs to be done to be able to secure that the calculations are correct and to see what kind of issues may show up during the actual execution work.

9.4 Benefits for TeliaSonera Finland

Business calculations will produce confidence for the management to decision making as to when technology change has to be executed. Technology will develop on a yearly basis, so it is important to understand underlying costs in old technology.

From the process point of view the benefits will be significant, because by having a common process covering both fixed and mobile network planning, TeliaSonera Finland will be able to avoid sub-optimizing. A common process with an area based approach will produce speed and business benefits to TeliaSonera Finland.
From a lifecycle management point of view this thesis will describe in an understanddable way that operators should not postpone mandatory investments even though timing may be tough from an economical point of view. If the mandatory investments are ignored, the burden of investments in the future may be too hard to carry out.

The management of the operators in general have to understand these three cornerstones in terms of profitable technology lifecycle management:

1) New technology will be more efficient both from an economical and energy consumption point of view which will support return of investment and benefit the cost ratio
2) Processes have to cover both fixed and mobile network planning to be able to avoid sub-optimizing
3) Life cycle management has to have better scope and operators have to reserve money in the budget for the mandatory technology re-investments.

9.5 Reflections

This has been an interesting and challenging journey. First version of the thesis, according to version numbering, was done on April 10th 2014. This means that the whole process took approximately one year. However there have been some challenges on the way. First of all TeliaSonera Finland had a massive re-organization and responsibilities were transferred to in some extent from corporate functions to the local country units. Another thing was that I personally changed my role from the networks area to products and services area. These two facts caused some delays, but executing the action research in a large organization like TeliaSonera Finland, you have to include quite a lot of colleagues to make the work successful. I personally feel lucky and honoured that I have had the possibility to work with highly skilled and motivated engineers and experts, who have helped me to complete the work. I feel very excited that
TeliaSonera Finland will carry out the geographical area three technology change in reality. I think that TeliaSonera Finland will be successful in the future and the most important thing is that the customers will experience this by better quality.

In a broader scope within the operators in Europe, I am aware that all big operators have the same challenge with old technologies as TeliaSonera Finland. Business cases i.e. return on investment (ROI) and benefits cost ratio (BCR) have been calculated in a way that those should be applicable for all operators using same the old technologies which are in use in TeliaSonera Finland. If operators want to be successful in the future, they have to establish clear roadmaps for changing the old technologies with future proof technologies. The work itself will take years, so a systematic approach is mandatory and allocating money for re-investments has to be in place on a yearly basis.

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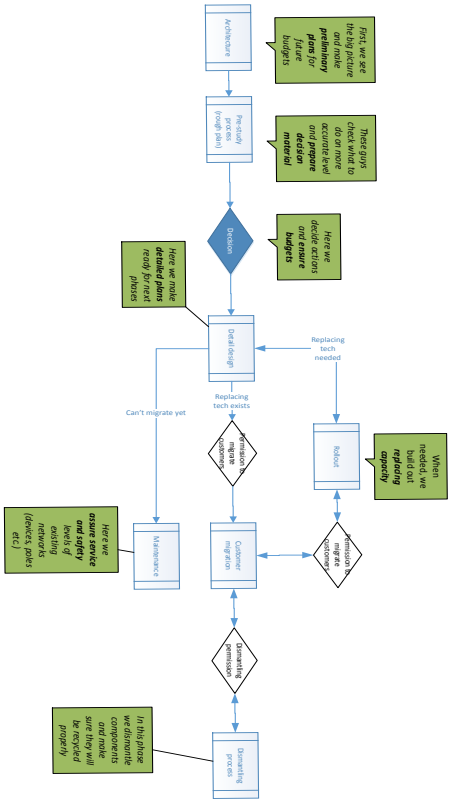
Detailed migration process flow



Energy and fault costs calculations

Network element	Energy kWh	Cost/Month 0,1	Yearly cost
PSTN Switch	7,5	540,00 €	6 480,00 €
Concentrator	0,2	14,40 €	172,80 €
DXX	0,2	14,40 €	172,80 €
PDH	0,1	7,20 €	86,40 €
SDH	0,4	28,20 €	338,40 €
Radio link	0,15	10,80 €	129,60 €
	2781		

Cost factor	Annually	Per NE	
Vendor support	50 000,00 €	17,98 €	
Repairing cost	115 000,00 €	41,35 €	
Fault fixing	750 000,00 €	269,69 €	
Total cost per Year	915 000,00 €	329,02 €	
New energy consumption	0,05	3,60 €	43,20 €
	1500	euros/ticket	

Fault cases North Carelia	Fault tickets	Cost 2013	
PDH	5	7 500,00 €	
SDH	15	22 500,00 €	
TOTAL:	20	34 890,56 €	
Fault cases Lappland	Faulty units	Cost 2013	
PDH	7	10 500,00 €	
SDH	20	30 000,00 €	
TOTAL:	27	49 112,01 €	
	17,98	euros/network element	
Support cost North Carelia		4 890,56 €	
Support cost Lappland		8 612,01 €	

Savings calculations

Number of dismantled NE's	Savings in North Carelia		Number of dismantled NE's	Savings in Lappland	Number of dismantled NE's	Savings in Loimaa
	0		0		0	
8	4 014,55 €		0		7	9 764,08 €
75	12 960,00 €		0		3	1 176,44 €
310	26 784,00 €		527	45 532,80 €	168	14 784,89 €
119	79 422,78 €		246	164 184,91 €	45	23 453,46 €
8	1 036,80 €		0		30	13 429,53 €
520			**773**		**253**	
Gross savings	**124 218,13 €**			**209 717,71 €**		**62 608,39 €**
New energy cost	7 732,80 €	/year	200	8 640,00 €	63	2 721,60 €
Net savings	**116 485,33 €**	**/year**		**201 077,71 €**		**59 886,79 €**

Detailed profit and loss calculation

Cash-flow and Profit/Loss impact

SUBJECT	**Test decision**			Calculation Period:	**5 years**
Prepared by	**xyz**			Calculation interest rate:	**7%**
Date of start	**2015-01-01**	Reference	0	Financing interest rate, debit:	**0,75%**
Alternative	**CR**			Financing interest rate, credit:	**3,50%**

Cash-flow		Year										KEUR
	KEUR	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
+	Revenues												0,0
+	Opex reductions	59 887	59 887	59 887	59 887	59 887	59 887						359 322,0
-	Capital expenditure, external	-105 611											-105 611,0
-	Capital expenditure, internal												0,0
-	OPEX & COGS external												0,0
-	OPEX & COGS internal	-4 000											-4 000,0
=	**Cash-flow**	**-49 724**	**59 887**	**59 887**	**59 887**	**59 887**	**59 887**	**0**	**0**	**0**	**0**	**0**	**249 711,0**
Σ	**Acc. cash-flow**	**-49 724**	**10 163**	**70 050**	**129 937**	**189 824**	**249 711**	**249 711**	**249 711**	**249 711**	**249 711**	**249 711**	**249 711,0**

Discounted Cash Flow												Total
=	Discounted cash flow	-49 724	55 969	52 308	48 886	45 688	42 699	0	0	0	0	0	
Σ	**DCF accumulated**	**-49 724**	**6 245**	**58 553**	**107 438**	**153 126**	**195 825**	**195 825**	**195 825**	**195 825**	**195 825**	**195 825**	**195 824,5**

P/L impact												Total
+	Revenues	0	0	0	0	0	0	0	0	0	0	0	0,0
+	Opex reductions	59 887	59 887	59 887	59 887	59 887	59 887	0	0	0	0	0	359 322,0
-	Operational expenditure	-4 000	0	0	0	0	0	0	0	0	0	0	-4 000,0
-	Depreciation												0,0
-	Writedown of existing assets												0,0
=	**Operating income**	**55 887**	**59 887**	**59 887**	**59 887**	**59 887**	**59 887**	**0**	**0**	**0**	**0**	**0**	**355 322,0**
+/-	Financial net interest	-186	178	1 226	2 274	3 322	4 370	4 370	4 370	4 370	4 370	4 370	33 032,7
=	**Net income**	**55 701**	**60 065**	**61 113**	**62 161**	**63 209**	**64 257**	**4 370**	**4 370**	**4 370**	**4 370**	**4 370**	**388 354,7**

FX-rate conversion of business case

FX-rate	9,0421

Cash-flow		Year										KSEK
	KSEK	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Total
+	Revenues	0	0	0	0	0	0	0	0	0	0	0	0,0
+	Opex reductions	541 505	541 505	541 505	541 505	541 505	541 505	0	0	0	0	0	########
-	Capital expenditure, external	-954 947	0	0	0	0	0	0	0	0	0	0	-954 946,6
-	Capital expenditure, internal	0	0	0	0	0	0	0	0	0	0	0	0,0
-	Operational expenditure external	0	0	0	0	0	0	0	0	0	0	0	0,0
-	Operational expenditure internal	-36 168	0	0	0	0	0	0	0	0	0	0	-36 168,5
=	**Cash-flow**	**-449 610**	**541 505**	**541 505**	**541 505**	**541 505**	**541 505**	**0**	**0**	**0**	**0**	**0**	########
Σ	**Acc. cash-flow**	**-449 610**	**91 895**	**633 400**	**1 174 905**	**1 716 410**	**2 257 915**	**2 257 915**	**2 257 915**	**2 257 915**	**2 257 915**	**2 257 915**	########

Discounted Cash Flow												Total
=	Discounted cash flow	-449 610	506 079	472 971	442 029	413 112	386 086	0	0	0	0	0	
Σ	**DCF accumulated**	**-449 610**	**56 469**	**529 441**	**971 470**	**1 384 582**	**1 770 667**	**1 770 667**	**1 770 667**	**1 770 667**	**1 770 667**	**1 770 667**	########

P/L impact												Total
+	Revenues	0	0	0	0	0	0	0	0	0	0	0	0,0
+	Opex reductions	-954 947	0	0	0	0	0	0	0	0	0	0	-954 946,6
-	Operational expenditure	-36 168	0	0	0	0	0	0	0	0	0	0	-36 168,5
-	Depreciation	0	0	0	0	0	0	0	0	0	0	0	0,0
-	Retirement of assets	0	0	0	0	0	0	0	0	0	0	0	0,0
=	**Operating income**	**-991 115**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**-991 115,1**
+/-	Financial net interest	-1 686	1 608	11 085	20 561	30 037	39 514	39 514	39 514	39 514	39 514	39 514	298 685,7
=	**Net income**	**-992 801**	**1 608**	**11 085**	**20 561**	**30 037**	**39 514**	**39 514**	**39 514**	**39 514**	**39 514**	**39 514**	**-692 429,3**